STATUS OF NASA'S PROGRAMS

HEARING

BEFORE THE

COMMITTEE ON SCIENCE
HOUSE OF REPRESENTATIVES

ONE HUNDRED NINTH CONGRESS

FIRST SESSION

NOVEMBER 3, 2005

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November 3, 2005

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STATUS OF NASA'S PROGRAMS

THURSDAY, NOVEMBER 3, 2005

HOUSE OF REPRESENTATIVES,
SUBCOMMITTEE ON ENVIRONMENT, TECHNOLOGY, AND STANDARDS,
COMMITTEE ON SCIENCE,
Washington, DC.

The Committee met, pursuant to call, at 10:15 a.m., in Room 2318 of the Rayburn House Office Building, Hon. Sherwood L. Boehlert [Chairman of the Committee] presiding.

COMMITTEE ON SCIENCE
U.S. HOUSE OF REPRESENTATIVES
WASHINGTON, DC 20515

Hearing on

Status of NASA's Programs

Thursday, November 3, 2005
10:00 a.m. – 12:00 p.m.
2318 Rayburn House Office Building

WITNESS LIST

The Honorable Michael D. Griffin
Administrator
National Aeronautics and Space Administration

HEARING CHARTER

COMMITTEE ON SCIENCE
U.S. HOUSE OF REPRESENTATIVES

Status of NASA's Programs

THURSDAY, NOVEMBER 3, 2005
10:00 A.M.—12:00 P.M.
2318 RAYBURN HOUSE OFFICE BUILDING

Purpose

On Thursday, November 3, 2005 at 10:00 a.m., the Committee on Science will hold a hearing to review the status of plans and programs of the National Aeronautics and Space Administration (NASA). NASA Administrator Michael Griffin will provide a comprehensive update on all facets of NASA's plans and programs.

When Administrator Griffin last testified before the Committee four months ago, on June 28th, he described several reviews he had recently initiated, including:

- the Exploration Systems Architecture Study (ESAS) to define NASA's plans for returning to the Moon;
- the Shuttle/Station Configuration Options Team (S/SCOT) to examine the range of options for completing the Space Station and retiring the Space Shuttle by 2010;
- a review of the goals and plans for Project Prometheus, NASA's nuclear power and propulsion program; and
- plans for managing the recent $1 billion cost overrun on the James Webb Space Telescope.

Since that hearing, NASA has made significant progress in completing these activities. NASA has completed and released the results of the ESAS study, it has released preliminary results of the S/SCOT study, it has decided to significantly scale back Prometheus to a technology research program, and it has decided to slip the schedule for launch of the Webb telescope by two years. As a result of these decisions, NASA has begun reprogramming fiscal year 2005 funds and modifying its request for fiscal year 2006 appropriations.

The hearing is also timely as the House and Senate are beginning to negotiate a conference version of the NASA authorization bill, and a conference report on NASA appropriations for fiscal year 2006 is expected to be completed shortly.

Overarching Questions

The Committee plans to explore the following overarching questions at the hearing:

1. How can NASA afford to maintain a balanced portfolio of science and aeronautics programs, while also completing the International Space Station and accelerating the human exploration programs, especially given the Agency's projected funding shortfalls?
2. What is the status of NASA's plans to define the final configuration of and research agenda for the International Space Station? What is the status of NASA's plans for returning the Space Shuttle to flight and for retiring it at the end of the decade?
3. What is the guiding philosophy NASA intends to use in developing new priorities for its aeronautics research program?
4. How does NASA intend to ensure the Agency has the appropriate size and skill mix in its workforce, as well as the facilities and infrastructure necessary to support the Agency's goals?

Key Issues (all discussed in greater detail in later sections of this charter)

Budget Dilemma. NASA's current plan is to fly 19 Space Shuttle missions between now and the end of 2010 (18 to the International Space Station (ISS) and one to service the Hubble Space Telescope). NASA has acknowledged that it is highly unlikely that it can accomplish the planned missions within the Shuttle's currently defined five-year budget, which is expected to decline by $4.8 billion over the next five

years. Some estimates show the Shuttle may need nearly $6 billion more than currently budgeted to accomplish these flights. NASA's options for handling the expected shortfall appear to be limited. If NASA does not receive a significant increase in its projected budgets over the next five years, it will either have to drop its plans to accelerate the development of a Crew Exploration Vehicle (CEV) or it will have to significantly cut science and/or aeronautics. NASA has already proposed significant cuts in some areas of its exploration budget and in Space Station research to accelerate development of the CEV.

Exploration Architecture Released and Accelerated. NASA has completed the Exploration Systems Architecture Study (ESAS). In the ESAS, NASA proposes to deliver the CEV in 2012, two years earlier than the date originally proposed by the President. If it succeeds, Americans would return to the Moon by 2018. NASA will develop two new launch vehicles to be derived from Shuttle elements, one to launch the CEV and one to launch heavier loads. To accelerate the development of the CEV and its launch vehicle, NASA has begun reprogramming funds from within the Agency's Exploration account. NASA has also increased its fiscal year 2006 request for the CEV and its launch vehicle by $785 million to $1.9 billion, a 70 percent increase. NASA estimates it will cost approximately $104 billion to send humans back to the Moon by 2019.

Space Shuttle Challenges Remain. The past three months have been a period of intense activity for the Space Shuttle program. The Stafford-Covey Return-to-Flight Task Group completed its work and issued its final report. The Space Shuttle completed its first "return-to-flight" mission but was subsequently grounded due to concerns from new foam debris. And, key Shuttle facilities were damaged in recent hurricanes, which along with investigations of the foam problem will delay the next Shuttle flight until at least May 2006.

The Stafford-Covey Task Group, which former Administrator Sean O'Keefe chartered to assess NASA's implementation of the *Columbia* Accident Investigation Board's (CAIB) 15 "Return-to-Flight" recommendations, issued its final report in August. The Task Group found that NASA had not met the CAIB's recommendations for (1) eliminating critical debris shedding from the External Tank; (2) hardening of the Shuttle orbiter against debris damage; and (3) developing the ability to inspect and repair the Shuttle in the event that it sustained critical damage. A minority opinion in the report further argued that NASA has not yet learned the lessons of the past, that NASA's cultural, management, and organizational problems persist throughout the human space flight program, and that NASA's leadership and management shortfalls generally made the return-to-flight effort more costly and lengthier than it needed to be. Since the time covered by the report, however, Administrator Griffin has installed new managers in top-level positions throughout the Agency, including within the human space flight program.

On July 26, NASA launched the Space Shuttle Discovery on the first mission since the demise of the *Columbia* Shuttle in February 2003. However, a few minutes after launch several chunks of foam fell off the External Tank. While the foam did not cause any damage to the Shuttle, it raised serious concerns over whether the problems that led to the *Columbia* accident had indeed been fixed. NASA then grounded the Shuttle fleet and established teams to review the potential causes of foam loss. The results indicate that the area where the largest piece of foam was lost had been damaged during ground processing of the tank. NASA believes it has traced the cause of other sources of foam debris, as well. While a final decision on how to address the foam problems has not yet been reached, NASA says it believes that tighter controls on processing and inspection, and a few specific and small design changes can prevent a repeat of the foam problem.

More recently, Hurricane Katrina caused significant damage to key Space Shuttle facilities, particularly the facility outside of New Orleans that manufactures the Shuttle's External Tank. Damage sustained from Katrina will cost the Agency an estimated $760 million. The Administration's latest Supplemental Appropriations request includes $325 million to cover part of the cost.

International Space Station (ISS) Configuration and Research Plan Cut. To determine what options the U.S. has in completing the ISS and meeting U.S. international commitments if it plans to retire the Shuttle in 2010, Administrator Griffin chartered the Shuttle/Station Configuration Options Team (S/SCOT). As a result, NASA now plans 18 more Shuttle flights to complete construction of the ISS in a way that will allow a six-person crew to work on-board. NASA will continue to use Russian vehicles, as necessary, to ferry crew and cargo to the ISS, and has promised to take steps to engage private companies for that task. NASA has announced that it will not launch one piece of equipment that had once been viewed as central to

ISS research—the centrifuge (technically the Centrifuge Accommodation Module (CAM), which the National Academy of Sciences has said is important to understanding the impact of long duration space flight on the body. Also, NASA has cut Space Station- related research funding by nearly half, from the original budgeted level for fiscal year 2005 of about $1 billion to $533 million under the most recent proposal for fiscal year 2006.

Aeronautics Plans Revamped. Administrator Griffin has appointed Dr. Lisa Porter, a former official at the Defense Advanced Research Projects Agency (DARPA) as the new Associate Administrator for Aeronautics. Since her arrival, Dr. Porter has begun significantly revamping the aeronautics program. Her basic thrust has been to move away from technology demonstration projects to more fundamental research, and she has eliminated much of the research on security issues. The NASA authorization bill that the House passed in July directs the Administration to develop a National Aeronautics Policy to guide NASA's aeronautics research program.

Background

Results of the Exploration Systems Architecture Study (ESAS)

The Exploration Systems Architecture Study (ESAS) outlines NASA's approach to implementing the *Vision for Space Exploration,* which was announced by President Bush in January 2004. The Vision calls for NASA to return the Space Shuttle to flight, complete the International Space Station, return humans to the Moon, and prepare to send humans to Mars and beyond.

To send humans back to the Moon, NASA plans to develop a Crew Exploration Vehicle (CEV) and a CEV launch vehicle (CLV), the latter of which will be based on the solid rocket boosters used by the Space Shuttle. To carry cargo and other equipment necessary to go to the Moon, NASA plans to develop a second launch vehicle capable of carrying more mass than the Saturn V rocket used in the Apollo program. That heavy-lift launch vehicle will use both the solid rocket boosters and a modified version of the external fuel tank used by the Shuttle. In this way, NASA hopes to take advantage of skilled labor and technical know-how it has already mastered in developing its new capability to carry crew and cargo into Earth's orbit as the first stage of a lunar mission. NASA examined and rejected alternative launch approaches such as using modified versions of the rockets that were developed to launch military satellites.

To carry humans from Earth's orbit to the surface of the Moon, NASA plans to develop new equipment, including a lunar command module, a lunar lander, and a vehicle to return the crew from the surface of the Moon to the command module. The CEV will be designed to carry six crew, and the lunar equipment to carry four crew. As these numbers are double the size of Apollo crews, Griffin has described the project as "Apollo on steroids."

In the ESAS, NASA proposes to accelerated the CEV by two years to 2012 from 2014, the date originally announced by the President last year. Griffin wants to accelerate the development of the CEV to minimize any gap in the U.S. ability to launch humans to space after NASA retires the Shuttle (which NASA must do to afford the new Vision and to reduce the exposure of astronauts to the risk of another Shuttle accident) in 2010. NASA intends to begin procurement of the CEV and the CLV later this year and anticipates awarding contracts in May and June of 2006, respectively. The heavy launch vehicle will be developed somewhat later.

The ESAS provides for a CEV capable of serving the International Space Station (ISS) as well as allowing human missions to the Moon for week-long stays as early as 2018. NASA hopes to embark on longer-duration stays on the Moon by 2022.

The ESAS changes the Prometheus Nuclear Systems and Technology program from a large development program to a relatively small research effort. The ESAS effectively postpones indefinitely the development of any major new nuclear capabilities while maintaining high-priority nuclear research efforts. The program will decline from roughly $430 million in fiscal year 2005 to $100 million in fiscal year 2006, of which $90 million is required for termination costs. NASA has said it needs to cut back any program that is not needed in the near-term to free up funds to accelerate CEV development.

NASA's estimate for the cost to implement the ESAS through 2011 is $31.3 billion with a 65 percent confidence level (meaning there is a 65 percent chance the cost will be no more than $31.3 billion). NASA is able to state the cost with that confidence level because most of its work in the next five years is dedicated to developing elements of the ESAS, such as the CLV and heavy-lift launch vehicle, based on existing technology. Costs for the remainder of the program are not as precise. NASA estimates the cost of returning humans to the Moon by 2018 to be roughly

$104 billion, but it has not developed an estimate of the confidence level of that estimate.

Status of Shuttle/Station Configuration Options Team (S/SCOT) Study

Griffin chartered a Shuttle/Station Configuration Options Team (S/SCOT) to determine what options the U.S. has for completing the ISS, given the plan to retire the Shuttle in 2010. Griffin has approved a plan for discussion with the U.S.'s international partners in the Station.

NASA has released a brief overview of some the study's main conclusions: NASA proposes to fly the Shuttle a total of 19 more times—18 flights to the ISS beginning no earlier than May 2006, and a possible additional flight to service the Hubble Space Telescope, pending a decision that such a flight can be made safely, which NASA has said it would consider after the successful completion of the first Shuttle flight next year. (Last February, NASA testified that expected that 28 more Shuttle flights would be made to the ISS.)

The S/SCOT plan would allow the launch of key ISS elements, enabling a six-person crew to work on board. But under the plan, NASA will cancel plans to launch the Japanese-built Centrifuge Accommodation Module (CAM) that was designed to study the effects of low-gravity on small mammals. (The ISS itself allows NASA to monitor the effects of zero gravity, but not the effects of low gravity, such as the levels experienced on the Moon and Mars.) The National Academy of Sciences has said in the past that the absence of a centrifuge could hinder NASA's ability to gain the knowledge essential to maintain astronaut's health, safety, and well being on long-duration space expeditions.

The research program for ISS has undergone significant changes since the announcement of the President's *Vision for Space Exploration.* The budget for Human Systems Research and Technology (HSR&T), the bulk of which is ISS research, is proposed to decline by nearly half from slightly more than $1 billion in fiscal year 2005 to $533 million for fiscal year 2006. (NASA's proposed fiscal year 2006 budget was originally $806 million, but it has subsequently revised the request, reallocating the funding so as to accelerate the development of the CEV and CLV—see below.) The cuts entail eliminating most research that does not relate to studying the impact of zero gravity on humans, for example research in the physical sciences. The proposed cuts will necessitate the termination of 322 grants.

Proposed Budget Amendments for Fiscal Year 2006

To implement the changes in the ESAS and S/SCOT, NASA has revised its fiscal year 2006 budget request twice since submitting the original request in February. In both cases the primary purpose was to provide additional funding to accelerate the CEV and CLV, and in both cases these funds were reallocated from within the Exploration Systems account.

The President submitted the first revision to NASA's budget as an official Budget Amendment that added $292 million to CEV and CLV development effort for fiscal year 2006. To pay for this increase, NASA proposed cutting $122 million from its Exploration Systems Research and Technology Accounts (advanced technologies for human and robotic missions to the Moon), $140 million from Prometheus (NASA's nuclear power and propulsion systems program), and $30 million from the Human Systems Research and Technology account (the bulk of which includes the funding for Space Station research).

The Budget Amendment also proposed to cut funding for future robotic missions to Mars to pay for near-term robotic Mars exploration programs, such as the Mars Science Laboratory and extension of the robotic rovers currently on Mars. The amendment would also provide $30 million to preserve the option of servicing the Hubble Space Telescope and would fully fund the Glory mission, an Earth Science mission that NASA has earlier tried to cut despite objections from several Members of Congress.

In late September, NASA submitted a second request effectively changing its fiscal year 2006 budget request as part of a fiscal year 2005 Operating Plan update, proposing to add an additional $493 million for CEV and CLV development efforts in fiscal year 2006. The plan would offset this increase by further cuts in the Exploration account. Specifically, it would cut Exploration Systems Research and Technology by an additional $174 million, Prometheus by an additional $76 million, and Human Systems Research and Technology by an additional $243 million.

While the original request for CEV and CLV development efforts was $1.1 billion, the two revisions to the budget request raise that amount by a total of $785 million to $1.9 billion (a 70 percent increase).

Projected Space Shuttle Budget Shortfall

While NASA is increasingly committing funds within the its exploration program to high-priority efforts to develop a CEV and CLV two years ahead of its original plan, the Agency is facing funding shortfalls in its Shuttle program. NASA's fiscal year 2006–2010 budget assumes that funding for the Space Shuttle program will decline by a total of approximately $4.8 billion over the next five years (see figure below) because of savings the Agency had said two years ago that it expected to realize as the Shuttle approached its retirement date of 2010.

NASA's FY06 Shuttle Budget Projection ($ millions)

	FY06	FY07	FY08	FY09	FY10	
Space Shuttle Budget	4,530	4,172	3,865	2,815	2,419	
Projected Reduction from FY06 level	0	-358.2	-664.9	-1,715	-2,111	Total -4,850

However, given the high fixed costs associated with the Shuttle program, NASA acknowledges that it is highly unlikely that these cost savings will materialize. Indeed, Griffin has said that even canceling the Shuttle and ISS station programs today would save little because of termination costs, international obligations and the need to keep Shuttle staff together because of the Shuttle elements that are part of the CEV and CLV design.

NASA is studying options to reduce Shuttle costs, however. One option is to reduce the Shuttle workforce to a single shift that would process one Shuttle at a time. (Currently, NASA operates multiple shifts, sometimes around the clock, to prepare three Shuttle orbiters for flight.) While such a move might save some money, it could reduce the number of Shuttle flights that could be processed to possibly as few as two per year, requiring NASA to rethink its plans for completing the Space Station by 2010.

A second option under consideration is integrating the Shuttle program and the Exploration program to take greater advantages of overlapping needs for workforce skills and facilities. While this approach may achieve some savings, particularly since NASA is planning to use at least some of the current Shuttle workforce and infrastructure in the CEV program, NASA is not likely to fully realize such savings in time to address these near-term shortfalls in the Shuttle's budget.

Hurricane Katrina Response and Recovery

Hurricane Katrina inflicted significant damage on Stennis Space Center in Mississippi and Michoud Assembly Facility in Louisiana. The Michoud facility is located just outside New Orleans and is the manufacturing facility for the Space Shuttle's External Tanks. NASA's cost estimate for the damage, including emergency response and programmatic costs is $760 million. To address immediate needs, NASA has identified $100 million in available funds—$15 from the Shuttle program and $85 million from International Space Station Crew/Cargo Services funding—that it has redirected toward NASA's immediate Katrina-related costs. NASA intends to repay the Shuttle and Space Station programs from any funds that Congress provides in an emergency supplemental appropriation.

Last week, the White House released a hurricane relief package to reallocate existing funds to address critical needs in the Gulf region. In this package, the Administration proposed to provide NASA with $325 million for the Michoud and Stennis centers—enough to cover expenses that would be incurred between now and May. It is not clear if a further supplemental request will cover the other half of NASA's hurricane expenses or if it will have to find that money by reprogramming other fiscal year 2006 funds.

Plans for Aeronautics Research

NASA's new plan for aeronautics will eliminate the four technology demonstration projects that were proposed in the fiscal year 2006 Budget Request: a project in subsonic noise reduction; a fuel cell powered aircraft; a project in sonic boom reduction; and a high-altitude, long-endurance, remotely-operated aircraft. Two other programs that were to be eliminated—hypersonics and rotorcraft—have been restored. A new "Foundational Technology" program is being created to focus on basic aeronautics research and to reinvigorate the Agency's core competencies; and NASA is realign-

ing several of its research programs to more directly address the needs of the Next General Air Transportation System, which NASA is pursuing in partnership with the Federal Aviation Administration and other agencies. NASA is also establishing a new office to manage its inventory of wind tunnels.

In addition to these Agency efforts, NASA has contracted with the National Academy of Sciences for delivery of an industry/academia consensus plan that prioritizes aeronautics research projects it believes NASA ought to pursue. Its report is due to be delivered to NASA early next summer.

Both the House and Senate versions of the authorization bill and the House version of the appropriations bill direct the Administration to develop a National Aeronautics Policy to guide NASA's aeronautics research program.

Webb Telescope Cost Increase

Earlier this year, NASA announced that the cost of the James Webb Space Telescope, the planned successor to the Hubble Space Telescope and one of NASA's highest priority space science programs, would increase by approximately $1 billion to a total of $4.5 billion. NASA attributed the cost growth to higher-than-expected costs for integration and testing, cost increases for the instruments, and program delays because of uncertainty in the selection of a launch vehicle. The cost overruns were especially surprising because they occurred at an early stage of the program.

NASA has completed a review of the various options to scale-back the telescope and reduce costs, but NASA concluded that a less capable telescope was less desirable than slipping the schedule to complete the telescope originally envisioned. The mission was scheduled to be launched in 2011, but has now slipped to 2013. NASA managers assert that they have the technical content, cost, and schedule of the program under control and do not expect that additional funding above the President's request will be needed in fiscal years 2006 or 2007. The detailed re-planning for the program is scheduled to be complete in April 2006.

Workforce and Institutional Issues

The reduction in aeronautics funding proposed in the fiscal year 2006 budget request could require the elimination of 1,100 civil service jobs at NASA centers, although NASA has said that there will not be any layoffs in fiscal year 2006. Also, the retirement of the Space Shuttle in 2010 and shift to the CEV will require NASA to make changes in the size and skill mix of a significant segment of the workforce at some centers. Work on the CEV and other elements of the mission to the Moon will significantly help offset the loss of Shuttle work, but some jobs and skills may still need to be eliminated. NASA may be able to help affected employees take advantage of training, retraining, and job placement programs to help the transition.

Questions Asked of the Witness:

Administrator Griffin was asked to describe NASA's proposed plans and the rationale for the changes in its programs since he last testified before the Committee this past June. He was asked to focus on the following:

(1) proposed plans for Exploration, including the likelihood that NASA will be able to accelerate the development of the Crew Exploration Vehicle;

(2) proposed plans to revamp the aeronautics research program, including the how they might affect NASA's facilities and workforce;

(3) proposed plans to reduce funding in Project Prometheus, Human Systems Research and Technology, and Exploration Systems Research and Technology;

(4) the status of plans for returning the Space Shuttle to flight, including efforts to reduce foam shedding and the impacts of the hurricanes to return to flight; and

(5) the range of options under consideration for flying the Space Shuttle and assembling the International Space Station.

(Budget authority, $ in millions)	Pres Bud Request FY 2006	Transfers	Program-matic Changes	Total Changes	Pres Bud Amend FY 2006	ESAS Changes*	Resulting Budget for FY 2006
Science, Aeronautics, and Exploration	9,660.9	168.4			9,829.3		9,829.3
Science	**5,476.3**	**-134.6**		**-134.6**	**5,341.7**		**5,341.7**
Solar System Exploration	1,900.5	-134.6	-98.4	-233.0	1,667.5		1,667.5
The Universe	1,512.2		10.1	10.1	1,522.3		1,522.3
Earth-Sun System	2,063.6		88.3	88.3	2,151.9		2,151.9
Exploration Systems	**3,165.4**	**303.0**		**303.0**	**3,468.4**		**3,468.4**
Constellation Systems	1,120.1	168.4	292.0	460.4	1,580.5	493.0	2,073.5
Exploration Systems Res & Tech (ESRT)	919.2	134.6	-122.0	12.6	931.8	-174.0	757.8
Prometheus Nuclear Sys & Tech (PNST)	319.6		-140.0	-140.0	179.6	-76.0	103.6
Human Systems Res & Tech (HSRT)	806.5		-30.0	-30.0	776.5	-243.0	533.5
Aeronautics Research	**852.3**				**852.3**		**852.3**
Aeronautics Technology	852.3				852.3		852.3
Education Programs	**166.9**				**166.9**		**166.9**
Education Programs	166.9				166.9		166.9
Exploration Capabilities	6,762.9	-168.4		-168.4	6,594.5		6,594.5
Space Operations	**6,762.9**	**-168.4**		**-168.4**	**6,594.5**		**6,594.5**
International Space Station	1,856.7	-168.4		-168.4	1,688.3		1,688.3
Space Shuttle	4,530.6				4,530.6		4,530.6
Space and Flight Support	375.6				375.6		375.6
Inspector General	32.4				32.4		32.4
TOTAL	16,456.2				16,456.2		16,456.2

* ESAS recommended modifications were reflected in notification provided in the September FY 2005 operating plan update. Resulting budget for ESRT, HSRT and PNST themes includes termination and transition costs.

QUESTIONS

Status of NASA's Programs

Witness: Administrator Michael D. Griffin
November 3, 2005

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Critical Questions

Additional Questions

Critical Questions

1. **Budget Dilemma.** Given NASA's proposal to accelerate the development of the Crew Exploration Vehicle (CEV), a $5 billion shortfall in Shuttle funding, and cost growth in other programs (like the James Webb Telescope), can NASA afford all the programs currently in its portfolio if it does not get additional funding over the next five years? If not, what are some of the options you are considering to bring NASA's overall portfolio in line with the currently projected agency budget over the next five years?

2. **Stafford-Covey Minority Report—NASA's culture.** The Stafford-Covey report included several minority reports. One minority report stated that NASA has not yet learned the lessons of the past, that NASA's cultural, management, and organizational problems persist throughout the human space flight program, and that NASA's leadership and management shortfalls generally made the return-to-flight effort more costly and lengthier than it needed to be. Do you agree with the conclusions of the minority report? Are there observations in the minority report that you disagree with? What are you doing to address the concerns raised by the minority report?

3. **Space Station Research Cuts.** Over the last year NASA has cut Space Station research funding nearly in half, from more than $1 billion in FY05 to $533 million for FY06. NASA is now going to focus on exploration-related research and has cut physical and life sciences research on ISS, such as molecular crystal growth, animal research and basic fluid physics. How problematic would it be to add this research back? Would it cause significant problems for your budget in the outyears?

4. **Shuttle Budgets FY06–FY10.** NASA's five-year budget (below) assumes the Shuttle program will require less funding every year until 2010, when it will be retired. In fact, the budget cuts the Shuttle by nearly $5 billion over the next five years. How realistic is this reduction? We understand that you are looking at scaling the Shuttle workforce back to a single shift and only launching the Shuttle a couple times a year. What impact would such a scenario have on the ISS program?

NASA Shuttle Budget FY06-FY10
($ millions)

	FY06	FY07	FY08	FY09	FY10	
Space Shuttle Budget	4,530	4,172	3,865	2,815	2,419	
Projected Reduction from FY06 level	0	-358.2	-664.9	-1,715	-2,111	Total -4,850

5. **Hurricane Katrina Funding.** The White House has asked for $325 million for NASA to pay for Katrina-related costs. However, NASA's believes it will need a total of $760 million, so NASA appears to be about $435 million short. What will be the impact in the funding shortfall? According to NASA this shortfall includes $204 million for Shuttle-related costs that must be paid for by the program, as well as $85 million that were taken from the funds necessary to pay the Russians to keep the ISS going (assuming that the bill to allow such payments, which the House recently passed, is passed into law). How will NASA absorb these additional costs? Will this shortfall delay the next Shuttle flight? Where will you get the funding to pay Russia for Soyuz and Progress vehicles?

6. **Exploration Program Budget.** The Exploration System Architecture Study (ESAS) estimated that the projected cost of the program though 2011 is $31.3 billion. How confident are you that this estimate is accurate? You have stated that the program can be funded within the currently projected exploration budget. However, the cumulative budget for exploration from FY06 through FY10 is only about $20 billion. Does this mean you will need $11 billion in FY11 for exploration alone to keep the program on track? What would be the impact of the schedule if the program was funded in FY11 at the FY10 level, which, according to NASA's five-year budget, is around $5 billion? How much would that delay the CEV or the return to the Moon?

7. **Workforce—Possible RIF.** According to NASA, the Agency currently has approximately 950 employees who are what the Agency refers to as "uncovered capacity"—they are not assigned to a program and are carried by overhead. And NASA has testified before this committee that it will not conduct a Reduction in Force (RIF) in FY06. How confident are you that NASA will be able to get through FY06 without a conducting a RIF? What about FY07?

Additional Questions

8. **Lessons Learned.** Administrator Griffin, you have testified before this Committee that "the Shuttle is extremely expensive to use, unreliable in its logistics, and operationally fragile." You said, "the Shuttle has met none of its original goals, despite the best efforts of some of our nations best engineers." What lessons can be learned from the Space Shuttle program so that we do not repeat them on the Crew Exploration Vehicle? Where did we go wrong then and what are we doing to avoid those mistakes?

9. **Historical Cost Growth.** Earlier this year NASA announced that the Webb telescope had a projected cost growth of $1 billion or about 30 percent. A few years ago the ISS announced a $5 billion cost increase. According to the CBO, NASA programs have, on average, grown in cost by 45 percent. Department of Defense programs, such as the Space-Based Infrared System and the National Polar Orbiting Environmental Satellite System, have also had little success in controlling costs. Is there a systemic problem with how government and industry are going about these programs? What needs to be done to fix these systemic problems? What are you doing to ensure that these problems don't plague the Moon exploration program?

10. **Foam and Debris Problems on Shuttle.** The Stafford-Covey Task Group completed its review of NASA's implementation of the *Columbia* Accident Investigation Board's (CAIB) return-to-flight recommendations and was not able to fully close out three items: (1) External Tank debris shedding; (2) Shuttle hardening against debris damage; and (3) inspection and repair of the thermal protection system. Do you concur that NASA was unable meet these CAIB recommendations? Is NASA going to continue work to try to meet these CAIB recommendations or have you done the best you can? Given the problems with foam shedding on the recent Shuttle flight, where is NASA in solving the problem?

11. **Shuttle Schedule.** What is the current status of the next Shuttle mission? What is your planning date for that launch, and what is your confidence level that it can be achieved? How much was the launch date affected by the damage caused by Hurricane Katrina to the Michoud Assembly Facility where the Shuttle External Tanks are made?

12. **Shuttle Workforce.** Administrator Griffin, how can NASA maintain the focus and technical rigor of the Shuttle workforce as the program winds down? What actions are you planning to take to ensure that Shuttle employees remain focused on the program as it winds down?

13. **Shuttle Logistics Carrier.** It is my understanding that NASA intends to spend $120 million to develop a new logistics carrier so the Space Shuttle can launch unpressurized cargo to the Space Station. According to the schedule, the new Shuttle-based cargo carrier would not fly until sometime in 2008, so we will only get a couple years of use before the Shuttle is retired in 2010. While NASA may not currently have the capacity to meet the demand to launch unpressurized cargo, does it make sense to develop a new capability for the Shuttle at this time? Isn't this exactly the kind of mission that should be met through a commercial cargo service?

14. **Hubble Servicing Mission Status.** Administrator Griffin, you have stated that you intend to preserve the option to perform a Hubble servicing mission. With the Shuttle grounded, at least until May of next year, how confident are you that you will still be able to perform the servicing mission? To what extent has the delay made the decision already a foregone conclusion?

15. **Shuttle Workforce Transition.** Can NASA use employees who now work on the Shuttle to help develop the Crew Exploration Vehicle or any other part of the new Moon exploration program? If so, to what degree are the skills transferable? What percentage of the workforce who work on the Shuttle today do you believe could work on exploration?

16. **Money to Russia.** The House recently passed an amendment to the *Iran Nonproliferation Act* bill giving NASA relief to make purchases from Russia for ISS through 2012, and we are optimistic that this bill will be passed by the Senate and signed into law. How much money do you think that the U.S. will need to send to Russia through 2012 to continue the ISS? What controls will be in place to ensure that the money gets to the appropriate people doing the work in the Russian space program?

17. **Russian Reliance.** The U.S. is, at this time and for the foreseeable future, totally reliant on Russia for crew rotation and cargo re-supply on the ISS. Even the Shuttle simply is not capable of remaining on orbit long enough to provide both these functions. What are you doing to ensure that the U.S. has a domestic source for the critical elements we need from Russia? Will the U.S. still be reliant on Russia in 2012?

18. **Cost of CEV Acceleration.** NASA has revised its proposed FY06 budget request twice. Both times funds were added to accelerate the CEV. In total, you have added $785 million to CEV for FY06 alone, a 70 percent increase. This brings the total FY06 request for CEV to nearly $2 billion. Given that you don't project to award the CEV contract until May and the CLV contract until June, do you expect to spend all $2 billion with only four months left to work in the fiscal year? If not, how far into FY07 would this funding carry the program?

19. **Cost to Return to the Moon.** NASA estimates that it will cost $104 billion over the next 13 years to return to the Moon by 2018. Is this an exact figure? How much confidence do you have in this number? Is the number an average of a range? If so, what is the range in the cost estimate?

20. **Commitment to Commercial Crew/Cargo Services.** Administrator Griffin, you have stated that you are committed to pursuing commercial crew and cargo services to support the ISS, but the CEV is being designed for these services as well. Entrepreneurs who want to provide a commercial service may be concerned that they will be competing with a government developed solution. What incentive does private industry have to invest in capabilities that have to compete with government systems? If commercial providers were to materialize, what would be the role of the CEV in servicing ISS? How would the development of options for commercial crew or cargo services to the ISS affect the development of the CEV and CLV?

21. **Role of Internationals in the Vision.** What will be your approach for bringing international participation into the exploration program? Do you have any thoughts on lessons-learned from the Space Station international partnership that might be helpful as we engage other nations with the Vision?

22. **Centrifuge Cut from Station.** NASA has recently announced that the Centrifuge will not be included in the assembly of the Space Station. In 1991, both the National Academy of Sciences and the White House Office of Science and Technology Policy stated that a Centrifuge was absolutely vital for conducting fundamental low-gravity research. Why did you decide to drop the Centrifuge? Without the Centrifuge, can NASA expect to conduct this basic research on ISS? Since Centrifuge was part of a barter arrangement with Japan in exchange for our launching of the Japanese Experiment Module (JEM), do you still plan on launching the JEM?

23. **Aeronautics Philosophy.** NASA has initiated several reviews of its aeronautics research program. What guiding philosophy does NASA intend to use in developing new priorities for its aeronautics research program?

24. **Aeronautics Workforce.** What are NASA's near-term plans for its aeronautics workforce? The FY06 budget submission, which was drafted prior to your arrival, assumes that 1,000 civil servants and contractors will be cut between now and FY07 (increasing to 2,000 civil servants and contractors by FY10). Yet in testimony this spring before the Space Subcommittee, NASA testified that workforce reductions would, in fact, not be as steep because of new work being parceled out to the centers. Unfortunately, NASA at the time was unable to provide any estimates of the degree to which workforce reductions could be mitigated by this new work. Can you provide new details on NASA's assumptions for its aeronautics workforce?

25. **Wind Tunnels.** NASA's inventory of wind tunnels has been an issue of significant interest to this committee. They represent a huge national investment, and also help ensure our civil and military aircraft can perform as designed. How does NASA plan on managing these assets?

26. **Financial Management.** During your last appearance before this committee in June, you called the status of NASA's financial management "deplorable." What actions have you taken to address this situation? Have you seen any notable improvements in NASA's financial management in the past four months? If so, what are they?

27. **Financial Management Progress.** At a hearing before this committee last week, NASA's Chief Financial Officer indicated that NASA is making progress in improving NASA's financial management in a number of areas. However, NASA continues to receive the lowest possible grade (red) in the President's Management Agenda scoring for both the status of financial performance and, perhaps more telling, for *progress* in financial performance. Do you know why NASA still gets red marks for this area in the President's Management agenda? What is NASA doing to improve its score for financial performance?

Chairman BOEHLERT. The hearing will come to order.

I want to welcome Administrator Griffin back to the Committee. After about six months on the job, I want to assure you, you are still our hero. You have retained your candor, and you have been remarkably successful at fulfilling the commitments you have made.

Dr. Griffin has put in place a top-notch management team. He has put meat on the skeleton of the vision for space exploration, has taken seriously the criticisms of NASA's culture, handled the Shuttle's return-to-flight responsibly, and proposed tough but needed cuts in several programs, and has demonstrated his commitment to ensuring that NASA has robust programs in aeronautics, space science, and Earth science. This is precisely what NASA has needed and just what we had hoped for from Dr. Griffin.

We are, I think, seeing the daunting renaissance of NASA inspired by the leadership of Dr. Griffin and his team. But a renaissance costs money. And I don't see anyone waiting in the wings to underwrite NASA. So while NASA may have relatively smooth sailing right now, we ignore the clouds on the horizon at our own peril.

Here is what I mean, and I will be blunt. There is simply not enough money in NASA's budget to carry out all of the tasks it is undertaking on the current schedule. That is a fact. The estimated shortfall between now and fiscal year 2010 is probably between $4 billion and $6 billion, and that is assuming that the current cost estimates for NASA missions are on the money, which is unlikely, even with the most careful cost estimating. NASA has gotten in trouble repeatedly in the past by making promises that are beyond its financial means to fulfill.

The *Columbia* Accident Investigation Board, among others, have described that folly in excruciating detail. I don't want to see us go down that path again.

Before NASA promises that it can accelerate development of the Crew Exploration Vehicle and complete construction of the Space Station and have worthwhile aeronautics and science programs, it ought to be able to demonstrate where the money will come from. And right now, it can't. And let me reiterate. As a supporter of the vision, NASA cannot use aeronautics and science as a piggy bank to fund human space flight. And I know Dr. Griffin shares that view.

The closest I have heard to an answer about these financial facts is, in effect, that we will address this financial shortfall in fiscal year 2008. That is not all that far away. And as far as I can see, the only thing that 2008 has to recommend itself is that it hasn't happened yet. I don't know why anyone would assume that we are going to be flush with cash in 2008. This "wait until next year" mantra may be soothing for baseball fans, particularly so to me, as a Yankee diehard, but it is a poor motto for budgeting.

Yet we are starting to hear it more and more. We are hearing it, for example, from officials at the National Oceanic and Atmospheric Administration when we asked how they are going to get their key satellite program back on track. But that is another subject for another hearing. I want to see NASA succeed. I want to see Dr. Griffin succeed. But we can't premise that success on money

that doesn't exist and isn't all that likely to exist. And the time to discuss those hard facts is now.

Congressional debate on NASA is dominated by two factions, neither of whom trouble themselves with this budget problem. The first and larger faction are those who don't care much about NASA and are particularly unimpressed with the vision. The smaller, but more effective faction, thinks NASA is a high enough priority that it should get additional money, no matter how tight the budget is.

I am in neither camp. I support the vision, but I think that it can't be allowed to break the bank or eat into NASA's other programs. And I hope we can get some guidance today about how folks like me—folks in the middle—the swing votes who can determine the outcome of debates, how we can and how we ought to proceed in this budget climate. It is a good time to have that discussion.

As we are beginning negotiations on our NASA authorization bill with our colleagues on the other side of the capital, and as Congress nears agreement on fiscal year 2006 appropriations, these are tough questions. But we have got the right man for the job at the helm at NASA to help us answer them. And that is why I think this hearing is particularly important.

Mr. Gordon.

[The prepared statement of Chairman Boehlert follows:]

PREPARED STATEMENT OF CHAIRMAN SHERWOOD L. BOEHLERT

I want to welcome Administrator Griffin back to the Committee. After about six months on the job, he is still our hero. He has retained his candor, and he has been remarkably successful at fulfilling his commitments.

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NASA has gotten in trouble repeatedly in the past by making promises that are beyond its financial means to fulfill. The *Columbia* Accident Investigation Board (CAIB), among others, have described that folly in excruciating detail. I don't want to see us go down that path again. Before NASA promises that it can accelerate development of the Crew Exploration Vehicle, and complete construction of the Space Station and have worthwhile aeronautics and science programs, it ought to be able to demonstrate where the money will come from. And right now, it can't.

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(NOAA) when we ask how they're going to get their key satellite program back on track. But that's a subject for another hearing.

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It's a good time to have that discussion, as we are beginning negotiations on our NASA authorization bill, and as Congress nears agreement on fiscal 2006 appropriations.

These are tough questions, but we've got the right man for the job at the helm at NASA to help us answer them.

Mr. Gordon.

Mr. GORDON. Thank you, Mr. Chairman.

As I listened to your remarks, I am reminded, in the turn of the century, there were brothers that ran for governor of Tennessee, Alf and Bob Taylor, and they called it the war of the roses. None of them were in the war, but one of them wore a red rose, the other one wore a yellow rose sort of as their symbol. And during the campaign, they debated across the state, normally staying together with each—you know, together at that Best Inns or other hotels or whatever. And even to the point—and sometimes changing their speeches. They would—you know, so they would give the speech that the other one gave the night before. And I could have just as well taken your statements today.

And I want the audience and our Committee to know that we are very much in sync, both in terms of our appreciation for Dr. Griffin's ability, as well as for the concerns about the direction of NASA.

So there are divisions, legitimate, maybe, and not legitimate in Congress on a variety of issues, but on this committee, at least from these two folks, there are no divisions on the statement that our Chairman has just made. So let that word go out.

Now let me welcome Administrator Griffin to our hearing today. And again, with all of the good things we all say about you, I want to point out something that is not so good. I don't think that it is so much your fault, but you, ultimately, are responsible. And that is that the testimony—your testimony today was not delivered until 4:53 yesterday afternoon for a 10:00 a.m. hearing. I know that OMB has to, I guess, clear these things. I want you to know that if this happens again, I will recommend to our Chairman that we follow Jim Sensenbrenner's example with NSF some time back and cancel the hearing. We simply can't do our job if we don't get that information sooner.

It has now been four months since Administrator Griffin first appeared before this committee as the NASA Administrator. Since that time, there have been a lot of changes, both to the NASA programs and to the NASA institution. We need to hear about these changes.

In addition, there were a number of important questions left unanswered at the hearing, and NASA's attempts to answer them have raised additional questions, some of which I hope will be addressed at today's hearing. When this committee held a hearing earlier this year on NASA's fiscal year 2006 budget request and the President's exploration initiative, I said, "I for one support the President's proposal if it is paid for and is sustainable." I stand by that statement.

However, I am very concerned that this Administration may not be willing to pay for the vision that it presented to the Nation 18 months ago. And I fear that the approach being taken to move the vision forward over the near-term may make it very difficult to sustain the initiative beyond 2008.

The result is that I believe we are no closer to a national consensus on the President's *Vision for Space Exploration* than we were 18 months ago. And that is unfortunate, but I believe that it is a reality.

And why do I say that? About a month ago, NASA released its plan for carrying out the exploration initiative. From a program management standpoint, it seemed to me to be very sensible. It maximized the use of existing technology. It narrowed the focus of the exploration program to achieving the President's goal of putting American astronaut boots back on the Moon by 2020. And it appeared to fit within the Administration's proposed exploration budget.

Given the constraints laid down by the Administration, it appeared to be the most efficient means of meeting the President's goal. And I think that Administrator Griffin and his team are to be commended for their efforts. Yet, it leads to the basic question of "are we doing the right thing or just doing the thing right"? That is, should simply getting to the Moon under the Administration's timetable be the Nation's goal?

Or should the goal be to craft a long-term, human and robotic exploration program that spawns new technologies, engages the best and brightest in our universities, and nurtures the R&D capacities that will be needed to meet long-term exploration goals as well as carry out NASA's other important missions?

Those are not idle questions, given that NASA is proposing to spend more than $100 billion over the next 15 years to get those astronauts' boots back to the Moon. And given that the leader of NASA's Exploration Systems Architecture Study recently acknowledged that $100 billion doesn't fund more than a couple of brief visits to the Moon.

He also confirmed that the assumption of limiting NASA's exploration budget beyond 2010 to inflationary growth, something the Administration cited when it announced the exploration vision to demonstrate its "affordability," won't get anyone to Mars. To quote him, "When you try to fit within a wedge like that, you are not going to have a human Mars program if you extend that out."

If that is the case, then it puts a premium on NASA having compelling answers to the questions: "Why do we need to go back to the Moon on NASA's proposed schedule; and what are we going to do when we get there?"

I hope that Administrator Griffin can provide those answers today, but I would caution him that he is likely to face a skeptical audience in the Congress as a whole.

That skepticism is likely to increase when the benefits of following NASA's plans are weighed against its costs to NASA's other programs. For example, while it is certainly commendable that the Administrator wants to carry out the exploration vision within the budgetary profile that he has been given by OMB, that profile puts NASA's aeronautics programs on a path of continued significant decline through at least the remainder of the decade.

And while his intent is to not take money from NASA's science programs to support the exploration vision, the reality is that NASA's life science programs are being gutted as we speak, and non-exploration-related research is being eliminated from the International Space Station program.

And in an attempt to reduce the size of the "gap" between the forced retirement of the Shuttle and the eventual deployment of the Crew Exploration Vehicle, the Agency is slashing its commitment to a variety of research and technology programs.

Finally, just weeks after NASA announced its goal of "essentially completing" the International Space Station, it appears that OMB guidance to NASA is putting the goal in serious jeopardy.

My intent in citing these examples is not to criticize Administrator Griffin. Rather, it is to make clear that only 21 months into the vision, NASA has already had to make major cuts to the programs and contemplate additional restructurings simply to have the hope of meeting the President's timetable for returning U.S. astronauts to the Moon.

That does not bode well for the sustainability of the vision, and it raises the fundamental question: is the *Vision for Space Exploration* an Administration priority or simply a NASA priority?

As you know, just one year after the President announced his vision for NASA, the White House cut NASA's out-year funding plan by over $2.5 billion. That simply worsened an already existing mismatch between NASA's programs and its budget.

When the Administration put forth its "sand chart" 21 months ago to demonstrate the "affordability" of the exploration vision, it assumed deep reductions in the funding required to the Shuttle program in the years prior to the retirement. The realism of achieving those Shuttle cost reductions are questionable, but OMB and NASA kept them in their budget plan.

And what is the result? NASA now has more than a $3 billion budget shortfall in the Shuttle account to deal with over the next several years as a result of OMB's and NASA's desires to construct a budgetary plan that would support the vision. And that shortfall could have a major impact on NASA's ability to meet its commitments to the International Space Station program, among other things.

Is the White House going to find the resources to correct for its earlier "low-balling" of Shuttle budgetary requirements? Is the White House going to ensure that the ISS is a facility that truly is an integrated part of the vision and that meets our commitments to our international partners? If not, it will be telling us—it will be a telling sign that this Administration is distancing itself from

its commitment to the exploration vision and leaving it to NASA to pick up the pieces.

Well, I hope that Administrator Griffin will be able to shed some light on these issues today. And again, I welcome him to this hearing.

[The prepared statement of Mr. Gordon follows:]

PREPARED STATEMENT OF REPRESENTATIVE BART GORDON

Good morning. I'd like to welcome Administrator Griffin to today's hearing.

It is now four months since he first appeared before this committee as NASA Administrator.

Since that time, there have been a lot of changes both to NASA's programs and to the NASA institution. We need to hear about those changes.

In addition, there were a number of important questions left unanswered at that hearing.

And NASA's attempts to answer them have raised additional questions—some of which I hope will be addressed at today's hearing.

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> *"I for one support the President's proposal if it is paid for and is sustainable."* I stand by that statement.

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Why do I say that? About a month ago, NASA released its plan for carrying out the exploration initiative.

From a program management standpoint, it seemed to me to be a sensible plan:

- it maximized the use of existing technology;
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Given the constraints laid down by the Administration, it appeared to be the most efficient means of meeting the President's goal. And I think Administrator Griffin and his team are to be commended for their efforts. Yet, it leads to the basic question of "are we doing the right thing-or just doing the thing right?" That is, should simply getting to the Moon under the Administration's timetable be the Nation's goal?

Or should the goal be to craft a long-term human and robotic exploration program that spawns new technologies, engages the best and brightest in our universities, and nurtures the R&D capabilities that will be needed to meet long-term exploration goals, as well as carry out NASA's other important missions?

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Well, I hope that Administrator Griffin will be able to shed some light on these issues today. I again want to welcome him to our hearing, and I look forward to his testimony.

Chairman BOEHLERT. Thank you very much.

The Chair recognizes the Chairman of the Subcommittee on Space and Aeronautics. And before doing so, I would like to observe that Chairman Calvert has been tireless and has visited the NASA Centers. He just never stops. And that is what we expect of the Chairman, because he succeeded his fellow Californian, Chairman Rohrabacher, who was just as indefatigable and just as energetic. I say that so that everyone will know this is a team up here, and now it is Chairman Calvert at the helm at the Subcommittee that is working day in and day out to ensure that we have the success that we all expect from NASA.

Chairman Calvert.

Mr. CALVERT. Well, thank you for that kind introduction, Mr. Chairman.

And I hate to do this to you, but I want to remind you that I am an Angels fan, and I am sure you were reminded of that last month. But I also am from the City of Angels, and so as a—you know, originally, and of course, the Angels play in Anaheim, but they call themselves the Los Angeles Angels.

But by that, I am an optimist, and it is great to chair the Space and Aeronautics Committee. So I come up to this with a spirit of optimism, and I certainly do that this morning as I welcome Administrator Griffin, as I know that he went into this job with a spirit of optimism, that this country can, and will, succeed.

And we welcome you back to update the Committee on the latest developments at NASA since you have appeared before us last June. You have had a lot on your plate. A lot of things have happened. As you know, last week, we were out there at John Space Center. I met with you after you had an all-hands meeting. And we were certainly—as you are going to mention, I suspect, in your testimony, anxious to see the Shuttle return-to-flight, which hopefully will be in May of 2006. We certainly want the Shuttle to fly when it is safe, and we certainly understand that the hurricane season has undermined the plannings to return-to-flight, but as you know, each month in delay of the Shuttle flight certainly effects NASA's credibility.

And I also understand that an old friend of ours, Shana Dale, who has been nominated to be your deputy, has sailed through her first step of the confirmation process, and she will be completing her confirmation hearing, I understand, next week. And even though I know you are a high-energy person, we know that you will be happy to have her on board and part of the team. She is a great addition, and we certainly look forward to working with her, certainly since most of us know her and have worked with her in the past.

The Committee is anxious to have you update us on a number of areas that you have changed over the last few months, and I think properly so. Since we met last week, three of the NASA Centers suffered through the Hurricanes Katrina, Rita, and Wilma. The AC has come out with this Exploration System Architecture Studies. NASA has just recently set up the new operations plan as well as a new budget amendment. Your Deputy Administrator named by the White House. You have appointed new Associate Administrators for all your mission directorates under NASA, Aeronautics, Research, Exploration Systems, Space Operations, and Science. In addition, some of your Centers are being reorganized to fit with the new vision. We are anxious to learn how you will be moving forward on this over the next year or so.

In my capacity as Chairman of the Space and Aeronautics Committee, I have enjoyed working with you and to move around—the—to NASA towards what I described as the second space age. As you know, the first space age was born of the Cold War and was maintained only so long as we were competitive with the Soviet Union. After the fall of the Soviet Union, the U.S. space program limped along for three decades, lacking vision and leadership.

I believe in this second space age we must feature the exploration of the universe while achieving synergy among our civil, commercial, and national security space programs. With your leadership, we now have the vision and leadership to provide this impetus for the second space age.

Recently, a panel of experts led by retired Chairman and CEO of Lockheed Martin, Norman Augustine, issued a report stating that we—what we already know. There has been an erosion of the

United States' competitive edge in science, engineering and mathematics. Increasingly, we are seeing strides in Asia and Europe rival or exceed America's competitive edge in those critical areas as science and innovation.

Last year, according to *Fortune Magazine,* more than 600,000 engineers graduated from institutions of higher learning in China, 350,000 in India compared to just 70,000 in the United States.

You know, Mr. Administrator, the best way to get our students interested in studying these hard subjects is to have exciting things for them to work on. NASA provides the impetus for future scientists and engineers by giving the exciting projects in which to work and about which to dream.

So I look forward to your success, because it is not only your success, it is America's success. And quite frankly, I am an optimist, as I mentioned in the beginning. You know. We will find the resources, because this country must succeed and we must continue, I think, to do the hard things.

So with that, I look forward to your testimony.

[The prepared statement of Chairman Calvert follows:]

PREPARED STATEMENT OF CHAIRMAN KEN CALVERT

Good morning, Administrator Griffin. We welcome you back to update our committee on the latest developments at NASA since you last appeared before us in June. You have a lot on your plate and a great deal has transpired in the last four months. Most recently, several Members, and I, met with you at the Johnson Space Center (JSC) following your all hands meeting with the JSC employees.

We are all anxiously awaiting the Shuttle's return-to-flight, currently set for May 2006. While we certainly want the shuttle to fly only when it is safe, and we certainly understand that the hurricane season has undermined all planning for the Return-to-Flight, each month delay in the next Shuttle flight affects NASA's credibility. We need to fly sooner rather than later.

I understand that Shana Dale, who has been nominated as your deputy, has sailed through the first step of her confirmation process this week, when she completed her confirmation hearing on Tuesday. Even though you are a very high energy person, I know you will be relieved to get her on board as part of your team. She will be an excellent addition, since her past experience as a staffer of this very committee, will lend the agency invaluable insight and support with the NASA's continued effort to improve communications with Congress.

The Committee is anxious to have you update us in a number of areas that have changed over the last few months. Since we last met, three of the NASA centers suffered through hurricanes Katrina, Rita, and Wilma; the Agency has come out with its Exploration Systems Architecture Studies (ESAS); and NASA has just recently sent up a new Operations Plan as well as a new budget amendment. Your Deputy Administrator has been named by the White House and you have appointed new associate administrators for all mission directorates under NASA—aeronautics research, exploration systems, space operations, and science. In addition, some of your centers are being reorganized to fit with the new Vision. We are anxious to learn how you will be moving forward over this next year or so.

In my new capacity as Chairman of the Space and Aeronautics Subcommittee, I have enjoyed working with you to move NASA towards what I describe as the Second Space Age. The first Space Age was born of the Cold War and was maintained only so long as we were competitive with the Soviet Union. After the fall of the Soviet Union, the U.S. space program limped along for three decades, lacking vision and leadership.

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Recently, a panel of experts, led by retired Chairman and CEO of Lockheed-Martin, Norman Augustine, issued a report stating what we already know: there has been an erosion of the U.S. competitive edge in science, engineering, and mathematics. Increasingly, we are seeing strides in Asia and Europe rival or exceed Amer-

ica's competitive edge in those critical areas of science and innovation. Last year, according to *Fortune* magazine, more than 600,000 engineers graduated from institutions of higher learning in China, and 350,000 in India, compared to just 70,000 in the United States. You know, Mr. Administrator, that the best way to get our students interested in studying these hard subjects is to have exciting things for them to work on. NASA provides the impetus for future scientists and engineers by giving them exciting projects on which to work and about which to dream. We thank you for your service and I look forward to hearing your testimony.

Chairman BOEHLERT. Thank you very much, Chairman Calvert. Distinguished Ranking Member, Mr. Udall.

Mr. UDALL. Mr. Chairman, thank you.

Since we are discussing baseball analogies this morning, and we are talking about what a great team we are, I do know our goal is, with all due respect to the New York Mets, not to be where one of our colleagues suggested the New York Mets are at this point in time, which is they are in the sixth year of their four-year plan.

And it is important to hear from Dr. Griffin today, so I don't want to belabor many of the points that have been made, but I did want to make it clear that I remain a strong supporter of NASA's exploration program. I want to echo the concerns, but also the optimism, of the three previous Members and their comments to Dr. Griffin.

But I think I do share the concern we all have about the cuts that NASA appears to be making to other vital NASA missions.

And I want to just cover a couple of examples that I think are important to discuss this morning.

The first is the situation facing NASA's life science program, and in particular, the Space Station research in general. NASA has decided to eliminate the life sciences Centrifuge that it had, until now, considered a centerpiece of the ISS research program as well as a U.S. commitment to the international partnership. And it appears that NASA is also making deep and, perhaps, irreversible cuts to NASA's life science program. And NASA has decided that it will no longer support fundamental and other non-exploration-related micro-gravity research on the ISS even though NASA has long justified the Nation's investment in the ISS in part on the basis of the terrestrial benefits to be derived from such research.

Second, despite your best intentions, Dr. Griffin, I am worried that NASA is going to have great difficulty in keeping a vital and robust set of space and Earth science missions on track in a tightly constrained NASA budgetary environment.

I hope I am wrong, because these science programs, as well as the university research activities that they support, are, in many ways, NASA's crown jewels in the eyes of the general public. But I do remain worried.

And then finally, I want to express my concern over the NASA's aeronautics program. You have once again changed the management of the program, and I want to wish the new Associate Administrator well, but it is clear under the Administration's current budgetary plan that her task will be to manage a budget that will continue to climb for the rest of the decade.

And I know NASA recognizes the importance of rebuilding its fundamental research and technology program in aeronautics. These budgetary constraints that are imposed on the program appear to make that rebuilding come at the cost of significantly

shrinking NASA's R&D that I believe is more directly relevant to the needs of the aviation industry. It doesn't make much sense to me, and I hope that NASA can embrace a more balanced portfolio.

In that light, in that spirit, there is a lot more to discuss.

Again, welcome, Dr. Griffin. I look forward to the spirited exchange that I am sure that we will have today and to your remarks.

[The prepared statement of Mr. Udall follows:]

PREPARED STATEMENT OF REPRESENTATIVE MARK UDALL

Good morning. I want to join my colleagues in welcoming Administrator Griffin to today's hearing.

We have a great number of issues to examine this morning, so I will be brief in my opening remarks.

However, before I begin, I would like to dispose of one "housekeeping" matter. Specifically, Dr. Griffin, it is now almost two months since I submitted some questions for the record to NASA following your last appearance before the Committee. It was not until yesterday that we received the responses.

As I think you can appreciate, it is difficult for us to exercise our oversight responsibilities properly without timely responses from the Agency. That said, I'd now like to turn to today's hearing, and I want to echo Ranking Member Gordon's concerns.

I remain a supporter of NASA's exploration program. I think it is important for the Nation's human space flight program to have challenging goals beyond low-Earth orbit, and I support a step-by-step approach to achieving those goals.

However, I continue to be troubled by the cuts NASA is making to other vital NASA missions—cuts that call into serious question the premise that the exploration Vision as currently implemented is truly "affordable."

Let me cite just a few examples. First, there is the situation facing NASA's life science program in particular, and Space Station research in general. NASA has now decided to eliminate the life sciences centrifuge that had until now been a centerpiece of the ISS research program as well as a U.S. commitment to the international partnership.

In addition, NASA is making deep and perhaps irreversible cuts to NASA's life science program. And NASA has decided that it will no longer support fundamental and other non-exploration-related microgravity research on the ISS—even though NASA has long justified the Nation's investment in the ISS in part on the basis of the terrestrial benefits to be derived from such research.

NASA's actions are particularly troubling given the language on the importance of that research and the need for NASA to maintain its commitment to it that is contained in both the House- and Senate-passed versions of the NASA Authorization.

Second, despite the best intentions of Administrator Griffin, I am worried that NASA is going to have great difficulty in keeping a vital and robust set of space and Earth science missions on track in a tightly constrained NASA budgetary environment as those missions inevitably have to compete with the growing demands of the human exploration initiative.

I hope I am wrong—because NASA's science programs, as well as the university research activities that they support, are in many ways NASA's "crown jewels" in the eyes of the general public. But I remain worried.

Finally, I have to express my continued concern over the state of NASA's aeronautics program. I am aware that NASA has once again changed the management of that program, and I want to wish the new Associate Administrator well.

However, it is clear that under the Administration's current budgetary plan her task will be to manage a budget that will continue to decline for the rest of the decade. Moreover, while I am encouraged that NASA recognizes the importance of rebuilding its fundamental research and technology program in aeronautics, the budgetary constraints imposed on the aeronautics program would appear to make that rebuilding come at the cost of significantly shrinking NASA R&D that is more directly relevant to the needs of the aviation industry and society as a whole. That makes little sense to me, and I hope that NASA will embrace a more balanced portfolio.

Well, there is much more to discuss, but I think it is more important at this point for us to hear from the Administrator. So I will again extend a warm welcome to Dr. Griffin, and I yield back the balance of my time.

Chairman BOEHLERT. Thank you very much, Mr. Udall.

Thank all of you for your participation. And at this point in the record, other Members are invited to submit any statement they wish to make, which will be included in the statement—in its entirety.

[The prepared statement of Mr. Costello follows:]

PREPARED STATEMENT OF REPRESENTATIVE JERRY F. COSTELLO

Good Morning. I want to thank NASA Administrator Griffin for appearing before the Committee to provide a comprehensive update on all facets of NASA's plans and programs.

On June 28, 2005, the Committee held its first hearing with Administrator Griffin to discuss a number of reviews that he had underway to restructure NASA's exploration planning, the International Space Station program, and other plans and programs. Most of the programs and equipment NASA uses and operates are expensive and requires a large budget. Unfortunately, NASA has endured financial management problems in the past and has been working to fix these ongoing challenges. However, it is my understanding that in the Subcommittee on Space and Aeronautics hearing last week, it was reported by the GAO and the NASA's office of Inspector General that NASA still has serious hurdles to overcome in implementing an effective financial management system.

In last fall's fiscal year 2005 Omnibus, the appropriators gave NASA a great deal of latitude in appropriated funds, with the understanding that the appropriations committees would review that allocation as part of the standard Operating Plan process. I am concerned that in the absence of any clear Congressional direction in an authorization bill or in the FY05 appropriation, NASA is making fundamental changes in its priorities and institutional arrangements in spite of their poor financial management practices. NASA's track record on the credibility of its cost estimates over the last several years is at best mixed. Overall, I am supportive of the mission and goals of NASA, but at the same time, we cannot ignore the half-trillion dollar deficit facing our country. Therefore, it is critical that this committee and Congress must continue to closely monitor NASA's funds in these tight financial times.

I look forward to hearing from the Administrator and to hear how these wide-ranging changes will impact NASA's future.

[The prepared statement of Ms. Johnson follows:]

PREPARED STATEMENT OF REPRESENTATIVE EDDIE BERNICE JOHNSON

Thank you, Mr. Chairman and Ranking Member.

I would like to extend a warm welcome to Administrator Griffin to today's hearing.

As a Texan, I want to express the utmost in pride and support for NASA.

Johnson Space Center, in my colleague Representative Tom DeLay's district, is a tremendous asset to Texas and to this nation.

This summer, NASA showed the world that the U.S. continues to succeed in its space and aeronautics programs. As former Ranking Member of the Research Subcommittee, I greatly value the advances this nation has made thanks to the work of NASA.

I believe so strongly in the importance of research and realize that many medical breakthroughs have resulted from space exploration research. Education continues to be important to interest bright minds for future. We must not overlook the need to grow young talent.

I look forward to hearing Administrator Griffin tell us about changes that have occurred in recent months that will make this great agency even better.

[The prepared statement of Mr. Honda follows:]

PREPARED STATEMENT OF REPRESENTATIVE MICHAEL M. HONDA

Chairman Boehlert and Ranking Member Gordon, thank you for holding this hearing today so that the Committee can fulfill its oversight responsibilities. Too often nowadays the oversight responsibilities of this body are being neglected. This committee is not without blame—many major changes have been made within NASA over the past two years without any hearings being held by the Committee.

My concerns with NASA revolve around what appears to be your very short-term focus on CEV and CLV, to the detriment of the long-term activities that are going to be necessary if we are going to successfully reach Mars. The decisions I am most familiar with, since they involve work that has been done at the Ames Research Center, are the decision to eliminate animal research aboard the International Space Station and the decision to either discontinue, descope, or delay work in the area of nanomaterials.

The ultimate goal of the *Vision for Space Exploration* is to send people to Mars. It's going to be a long mission, it's going to take a long time to develop the technology to successfully get people there, and we need to learn a lot about how our own bodies and those of the plants and animals we will rely on for food during the journey will behave under conditions unlike those we have ever experienced. It seems to me that by actively terminating ongoing work in these important long range areas, NASA is guaranteeing that the work isn't going to get started until later in the process. It is going to take even longer to make the breakthroughs that will be needed and gain the understanding that will be needed to get to Mars, and it is going to cost more to do that work in the end, too, since NASA will have to build up again what you're planning to dismantle now.

I've heard this approach justified as "go as you pay.'" This new nod toward fiscal responsibility from the Administration is interesting, and I wish it had been applied to tax cuts, but in this case it is going to mean that the goal of going to Mars is not going to be reached, at least not on the timeline or within the cost estimates that the President proposed. President Kennedy didn't take this kind of approach when he challenged our nation to put a man on the Moon. In fact, he noted "the facts of the matter are that we have never made the national decisions or marshaled the national resources required for such leadership. We have never specified long-range goals on an urgent time schedule, or managed our resources and our time so as to insure their fulfillment."

President Kennedy understood that to get to the Moon, we needed to specify long-range goals and commit the resources that would be needed to achieve them. And he recognized that "if we are to go only half way, or reduce our sights in the face of difficulty, in my judgment it would be better not to go at all." It seems to me that in this instance, NASA is only going half way. The final goal of going to Mars is being pushed aside so that work can be done to go back to the Moon. The singular focus on the short-term trip to the Moon is killing the long-term effort we need to get to Mars. I know I'm not alone in these views—I understand that the Ames federal employees union wrote to Administrator Griffin about this matter in the context of the cancellation of the ISS centrifuge, but never received a response.

[The prepared statement of Mr. Carnahan follows:]

PREPARED STATEMENT OF REPRESENTATIVE RUSS CARNAHAN

Administrator Griffin, thank you for appearing before us again today.

I was pleased to hear your testimony before us just four months ago, and appreciated your forthright answers and willingness to take on the difficult challenges NASA currently faces.

I am eager to learn more from you about new plans to go to the Moon and how this will affect the scheduled Shuttle launches that are needed to work on the International Space Station. I also look forward to hearing about how NASA will rebound from the affects of Hurricanes Katrina and Rita and how the hurricanes have affected the return-to-flight schedule.

I look forward to hearing your testimony.

[The prepared statement of Ms. Jackson Lee follows:]

PREPARED STATEMENT OF REPRESENTATIVE SHEILA JACKSON LEE

Chairman Boehlert, Ranking Member Gordon,

I want to thank you for organizing this important hearing to discuss the future of NASA. I want to welcome Dr. Griffin, the new NASA Administrator and thank him for coming before this committee this morning. NASA faces a watershed moment after having endured a tremendous tragedy in the *Columbia* disaster and now trying to map its future with a return to the Moon and manned exploration of Mars.

Unfortunately, while I wholeheartedly support the work of NASA, I am deeply concerned that the President's budget does not meet all the needs for future space exploration as we move forward in this new century. A lack of necessary budget authority makes the job for a new Administrator much more difficult and brings in

to question the true vision for NASA. As I have stated before, this Administration has made many bad budgetary choices, which continue to push us further into a huge deficits and mounting debt during the last four years. In addition, the President has proposed a highly questionable plan for Social Security along with an uncertain military future in Iraq that in conjunction with proposed $1.6 trillion tax cuts will result in less funds being available for vital agencies such as NASA.

I have been supportive of President Bush's *Vision for Space Exploration* because I firmly believe that the investment we make today in science and exploration will pay large dividends in the future. Similarly, I do not want to put a cap on the frontiers of our discovery, NASA should aim high and continue to push our nation at the forefront of space exploration. However, I find it hard to be more supportive of the President's plan, when I have no real specifics as to what this plan will entail. Large missions of this sort require detailed planning and as a Members of Congress we deserve to know how exactly the President's plan proposes to accomplish its objectives so that we can set out the proper resources and provide the necessary oversight. In addition, the President stated that the fundamental goal of his directive for the Nation's space exploration program is ". . .to advance U.S. scientific, security, and economic interests through a robust space exploration program." I could not agree more with that statement; unfortunately, this President's own budget does not meet the demands of his ambitious agenda. One year after the Administration laid out a five-year funding plan for NASA that was intended to demonstrate the affordability and sustainability of the exploration initiative, the Administration submitted a budget proposal for 2006 that would reduce that funding plan by $2.5 billion over the next four years. For example, in 2006, the Administration is seeking $546 million less than it said would be needed for NASA in 2006 in the five-year funding plan that accompanied last year's request. In fact 75 percent of the $2.5 billion shortfall will fall to NASA's science and aeronautics programs. This kind of under-funding for vital programs is unacceptable. Again, it is even more alarming because the President has not provided a detailed plan as to how he intends to accomplish his space exploration agenda; certainly draining money from the budget will not help that cause. I hope Administrator Griffin will be able to shed some light on the vision of NASA with the current budget shortfalls.

My greatest concern at this point is that we may not allocate enough money or resources to ensure the safety of all NASA astronauts and crew. After the *Columbia* disaster, safety must be our highest priority and it is worrisome that there is not a noticeable increase in funding to address all safety concerns. Presently, NASA is working towards a resumption of Space Shuttle flights, with the date for such a launch in uncertainty at this point. However, once NASA returns the Shuttle to flight status, it is then supposed to begin the task of figuring out how to retire the Space Shuttle fleet in 2010 while continuing to fly the Shuttle safely up to the very last flight. I am concerned that pressure to retire the Shuttle by a fixed date to free up resources for other activities, coupled with the need to fly up to 28 Shuttle flights to assemble the Space Station, could—if not handled properly—lead to the types of schedule and budgetary pressures that were cited by the *Columbia* Accident Investigation Board (CAIB) as contributing to the *Columbia* accident. I hope this concern is paramount at NASA as we move forward in the future.

As Members of this committee know I have always been a strong advocate for NASA. My criticism of the President's budget and its relation to the vision for NASA is intended only to strengthen our efforts to move forward as we always have in the area of space exploration and discovery. NASA posses an exciting opportunity to charter a new path that can lead to untold discoveries. As always I look forward to working with the good men and women of NASA as we push the boundaries of our world once again.

Chairman BOEHLERT. So that you don't think this is a complete love inn, there are some issues where there is disagreement up here. I have heard Mr. Gordon's statement and Mr. Udall's statement, and there is one area where there is a difference of opinion. I fully support, Mr. Administrator, your proposed cuts in Space Station research and technology development programs. Those aren't the science programs that I am most worried about.

So I think you are right on line with the way in which you are proceeding. And so I want to make sure that that is clarified for all.

Let me start by saying—oh, yeah. You know what? I was going to skip you.

Dr. GRIFFIN. Actually, that would be just fine.

Chairman BOEHLERT. With that, let me welcome the Administrator of NASA, Dr. Griffin.

STATEMENT OF HON. MICHAEL D. GRIFFIN, ADMINISTRATOR, NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

Dr. GRIFFIN. Thank you, Chairman Boehlert, Ranking Member Gordon, Subcommittee Chair Calvert, Ranking Subcommittee Member Udall, for inviting me to appear before you to provide an update on NASA's plans and programs since I appeared last June.

I do respectfully request that all sports analogies from here on out, however, be golf analogies so that I can understand the metaphor being used. But with that——

Chairman BOEHLERT. Without objection, so ordered.

Dr. GRIFFIN. Thank you.

A lot has happened since last June, and I believe that NASA, with your help, has made some steady progress. It has not been easy. The NASA family has suffered setbacks, especially in the aftermath of Katrina. A lot of work needs to be done, and we need this subcommittee's—this committee's help in maintaining our progress.

That makes—that includes the difficult progress—the difficult yet steady progress we are making in NASA's Financial Management System, the subject of Chairman Calvert's hearing last week.

Chairman Boehlert, in your letter of invitation, you asked me to provide the Committee with an update on a number of issues. We are working in a dynamic environment. I hope the Committee will understand that we are still in the throws of numerous issues arising from the Shuttle program following our first test flight in the return-to-flight sequence, the effects of Hurricane Katrina on the Shuttle program, and the formulation of the 2007 budget.

With that said, I will try to answer your questions to the best of my ability.

But first, on behalf of NASA, I do wish to thank the many Members of this committee and the Congress as a whole for helping us resolve certain legislative restrictions that were placed on cooperation with Russia that would have prevented with crew rescue support for the Station and necessitated U.S. astronauts de-crewing Space Station.

The Administration maintains our nation's nonproliferation objectives, but does recognize the value of effective cooperation with our Space Station partners. We just recently celebrated our fifth consecutive year of continuous human presence on board the International Space Station. With your help, we hope to celebrate a sixth.

We are now working with the Senate on this legislation so that our astronauts can continue to train on the Russian Soyuz vehicle. So again, thanks to you and to your staff for helping with this problem.

Now to your questions.

Since last June when we met, NASA conducted the first of our return-to-flight missions with the Space Shuttle Discovery com-

manded by Eileen Collins. The flight was safe, but not without surprises. Cameras onboard the external tank showed that we still had not completely solved the foam-shedding problem. We chartered a new and independent "tiger team" to look into this problem. We think we understand what went wrong with our workmanship on the external tank foam and that we will be able to fly our second flight with the Space Shuttle Discovery commanded by Steve Lindsay next May.

Since the last Shuttle flight, NASA's Michoud Assembly Facility near New Orleans and Stennis Space Center in Mississippi, both facilities critical to the Space Shuttle program, suffered the devastating effects of Hurricane Katrina.

NASA is, in fact, forever in debt to the 37 volunteers who stayed behind to ride out the storm at the Michoud facility. The ride-out crew positioned sandbags, reinforced doors, and most importantly, operated four diesel generators when municipal power failed in order to protect the facility and the space flight hardware from the storm. Most importantly, these diesel engines pumped more than one billion gallons of rainwater away from the levy to prevent flooding of the 830-acre facility. With 14 inches of rain and 150 mile-per-hour winds, every building on the Michoud facility suffered structural damage while the surrounding area was completely devastated. Today, there are almost no businesses or habitable homes within a 10-mile radius of Michoud.

Almost ¾ of our personnel, 1,500 out of 2,000 who work there, have returned even though some of them have slept in offices in hallways because they have no homes to which to go.

In addition to Michoud, Stennis Space Center in Gulfport, Mississippi was the FEMA Command Center in the region after Hurricane Katrina and provided medical care and food to over 3,000 evacuees. Men and women at Stennis were instrumental to the search and rescue as well as recovery operations in the devastated region.

All NASA Centers have contributed resources and people to this effort. These efforts are nothing short of heroic. Both facilities are critical to Space Shuttle operations, as Michoud manufactures the external tank and Stennis test fires the engines. Because of their dedication to human space flight, we are still able to conduct the modifications needed on the external tanks for the next Shuttle mission, and last week, Stennis test fired a Shuttle main engine in preparation for that flight.

Last week, the Administration submitted to Congress a supplemental appropriation for NASA of approximately $325 million to deal with the damage to Michoud and Stennis, and the Administration may seek future supplemental appropriations as we continue to deal with the aftermath of Katrina.

But NASA has many other uncertainties remaining with the costs of operating the Shuttle, and we are dealing with these issues on a daily basis. We, therefore, ask Congress for some measure of transfer authority between budget accounts in order to deal with unforeseen Shuttle costs and day-to-day problems in returning the Shuttle to flight. We need this committee's help in granting that transfer authority, and I promise you that NASA will keep the Congress fully informed, if it is granted.

Mr. Chairman, in your letter, you asked me to address the impacts of the hurricanes on return-to-flight. While I am confident of our technical ability to return the Shuttle to flight next year, I am concerned about longer-term consequences of the hurricanes over the next several years. There remains uncertainty about whether or not we will have an adequate workforce to return to Michoud. NASA's external tank production capability depends on that workforce, and we still need to manufacture several more Shuttle tanks to achieve NASA's desired 19 flights, which consist of 18 for Space Station assembly and one for the Hubble Space Telescope between now and the end of September 2010.

For this reason, our planned flight sequence is ordered such that less critical logistics flights are at the end of the sequence, and we are not focusing solely on the exact number of Shuttle flights to achieve the goal of assembling the Station and providing adequate logistics before commercial ISS crew cargo capabilities or the CEV come online.

Moving to some of the other questions you have had, last September, NASA provided to the Congress our Space Exploration Architecture plans with the Crew Exploration Vehicle and the launch systems supporting missions to the International Space Station, Moon, and Mars. We briefed many of you and your staff on the details of this architecture.

As the President articulated in his budget amendment for NASA last July, NASA is redirecting funds to accelerate development of the CEV. I wish to emphasize, this is not new money. It is not a plus-up for NASA. We are redirecting resources within NASA to make the CEV available as soon after Shuttle retirement as possible.

We realize that there are many pressures on the federal budget, and we have adopted a "go-as-you-can-afford-to-pay" approach toward space exploration.

But it is important to recognize that the *Vision for Space Exploration* is not about new money for NASA; it is about redirecting the money that we have.

Now this philosophy also means that NASA must set priorities among the goals of the exploration architecture itself. As I have said to this committee, and as you, Chairman Boehlert, said moments ago, NASA simply cannot afford to do everything on its plate today. We must focus our efforts on those technologies which support the urgent requirements of the exploration architecture. Thus, we are de-scoping, discontinuing, or deferring several research and technology projects, including some that I believe we will eventually need, like surface nuclear power systems. But these projects do not support the CEV and its associated launch systems and so must be deferred.

We are also deferring a number of research activities on the Space Station until after the CEV comes online, we hope, by 2012, because we simply cannot afford to do that research today.

Over the long run, our research efforts, as well as the research of other government agencies, like the National Institutes of Health, commercial industry, and our international partners, will benefit from the expedited development of the CEV and an accompanying ISS commercial crew and cargo capability.

So let me be clear. The primary objective of the exploration architecture for the next several years is not an immediate return to the Moon, but it is to develop a new capability to carry humans to low-Earth orbit and beyond, following the orderly retirement of the Space Shuttle. This is absolutely essential if we wish to maintain our leadership role in space exploration. Painful choices must be made, and we must suborn other priorities to that primary objective.

Mr. Chairman, you also asked me to address NASA's proposed plans to reinvent aeronautics research.

We are working closely with the White House Office of Science and Technology Policy to coordinate this national aeronautics research policy with other agencies, like the Department of Defense and FAA. Our primary goal is to re-establish our dedication to the mastery and intellectual stewardship of the core competencies in subsonic, supersonic, and hypersonic flight. And we will work closely with the universities and industries, where appropriate, to do that.

We plan to invest in our in-house expertise to ensure that NASA remains a world-class resource with personnel, facilities, knowledge, and experience ready to be drawn upon by the civilian community, other government agencies, and industry.

NASA's new Associate Administrator for Aeronautics, Dr. Lisa Porter, has briefed several Members of Congress and your staff, and she will continue to keep you informed as NASA further develops our aeronautics research plans and budgets, including our stewardship of NASA wind tunnels to expand the range of flight regimes.

Our nation needs to remain on the cutting-edge of aeronautics research. We will need your help, as well as that of our partners, in turning that goal into a reality.

NASA's science program has accomplished a great deal since I last reported to you.

On the 4th of July, we created our own fireworks display when the Deep Impact mission slammed into a comet at 23,000 miles-per-hour. We launched the Mars reconnaissance orbiter last summer, and we hope to soon launch Calypso and Cloudset Earth science missions.

After the next Shuttle mission, NASA will determine and will convey to you whether we believe that we can conduct another servicing mission to the Hubble Space Telescope with the Space Shuttle. The Hubble continues to unlock the mysteries of the universe, so—such as earlier this week, NASA scientists discovered two moons orbiting Pluto using the Hubble Telescope.

NASA also plans to launch New Horizons to Pluto early next year. As I reported to this committee earlier, we are conducting an in-depth review of the technical challenges and cost projection of the James Webb Space Telescope. I will report back to you early next year about our plans with that mission.

A lot has happened since I appeared before your committee in June. We have been busy at work, and we are making steady progress.

I would like to leave you with this thought. To me, space is the frontier for societies of the 21st century and beyond. Americans

have pioneered frontiers of land, sea, and air in the past. We must accept the challenge of this new frontier as well. Where others go, America must be prepared to lead.

There is a lot more to discuss with you and the Members of this committee, so I will stop here and answer your questions more directly.

Thank you.

[The prepared statement of Dr. Griffin follows:]

PREPARED STATEMENT OF MICHAEL D. GRIFFIN

Mr. Chairman and Members of the Committee, thank you for this opportunity to appear today to update the Committee on NASA's plans for the future and our progress in implementing the *Vision for Space Exploration.* Since testifying before the Committee in June of this year, NASA has made substantial progress in defining a safe and sustainable approach to a program of renewed space exploration beyond low-Earth orbit, while maintaining a balanced program for Exploration Systems, Space Operations, Science, and Aeronautics Research. This necessitates that we carefully weigh all the changes and adjustments we are making in our transition work to assure that the exploration program results in a safer and more reliable access to space while we continue to perform NASA's mission safely with the Shuttle.

- We have defined the architecture for space exploration, and outlined our plans for development of the Crew Exploration Vehicle and associated launch and support systems.
- We have adopted a "go-as-you-can-pay" approach toward space exploration, and have set clear priorities and made difficult choices to remain within the budget for exploration.
- We better understand the problem of foam insulation being released from the Space Shuttle external tank. This problem was identified by the cameras that we added to refine our understanding of this issue that, despite our best engineering judgment, surprised us during the launch of Discovery (STS–114) in July. Following the recommendations of the "tiger team" charged with addressing the newest instance of foam loss, we have defined the improvements necessary to fly again and will replace and modify areas of insulation on the external tank from which foam was shed. The design of our future transportation systems eliminates this problem by placing payloads on top of the propellant tanks, rather than on the side as with the Shuttle orbiter.
- We have completed the Shuttle/Station Configuration Options Team (SSCOT) study to evaluate options for the assembly and utilization of the International Space Station (ISS), taking into account the President's decision to retire the Space Shuttle by 2010, while still honoring U.S. commitments to the Space Station International Partners. Based in part on this assessment, we have developed a plan to move forward and begun discussions with our international partners.
- We established a new balance among planetary science, Earth science, solar physics, and astronomy within the overall science program.
- We are reshaping our Aeronautics research program to focus on core competencies, activities appropriate to NASA's unique capabilities, and activities that directly address the needs of the Next Generation Air Transportation System in partnership with other agencies.

As requested in your invitation to testify, the remainder of my statement will elaborate further on NASA's progress in each of the areas mentioned above. In addition, I would like to update the Committee on our progress in two other areas critical to NASA's success—retaining a robust science portfolio and ensuring a balanced workforce skill mix and productive NASA Centers to complete the Agency's work over many years.

NASA Plans for Exploration

As communicated to the Committee by letter dated September 19, 2005, NASA has completed the Exploration Systems Architecture Study (ESAS), which outlines NASA's approach to implementing the *Vision for Space Exploration.* The Vision calls for the Agency to return the Space Shuttle to flight, complete the International Space Station (ISS), and move on to the exploration of the Moon, Mars and beyond.

Based on the ESAS recommendations, NASA has now laid out a detailed plan to support sustained human and robotic lunar exploration operations, accelerate the development of the Crew Exploration Vehicle (CEV) and launch systems for missions to the ISS, Moon, and Mars, and identify key technologies required to enable this exploration architecture.

This plan offers a safe and sustainable approach to space exploration. An important aspect of this plan is that it is a "go-as-you-can-pay" approach, within planned budgets for Exploration Systems, through redirection of funding for longer-term and lower-priority research and technology (R&T) elements within the Exploration Systems Mission Directorate (ESMD). The resulting exploration program implements the ESAS recommendations.

NASA's goal is to deploy the next human space flight system, the Crew Exploration Vehicle (CEV) not later than 2012. The first flights will be to the ISS, but the primary goal of the CEV is to support subsequent exploration efforts, including human return to the Moon for week-long stays as early as 2018, but not later than 2020. Longer-duration human presence on the Moon is targeted for 2022. This is accomplished by redirecting existing funding for longer-term and lower-priority R&T elements within the ESMD, while focusing on those R&T activities that support the acceleration of the CEV, launch systems, and high-priority, long-lead items.

As we move forward, NASA will continue working closely with our International Partners to determine how they may best contribute to the *Vision for Space Exploration.* NASA will develop the transportation infrastructure needed to carry crews and cargo to and from the lunar surface. We hope to work with other space agencies to extend this core capability and expand the range of activities we carry out on the lunar surface. We also hope to cooperate with them on robotic precursor missions and planning for eventual human missions to Mars.

NASA also needs a strong partnership with industry. We will release a draft CEV Call for Improvements (CFI) in the December/January timeframe, and we are pursuing innovative programs to encourage entrepreneurs. Later this month NASA will issue a draft solicitation requesting commercial service demonstrations for ISS crew and cargo delivery and return. Where commercial providers have demonstrated the ability to meet NASA needs and safety requirements, commercial services will be purchased instead of using government assets and operations.

However, NASA needs more than vibrant international and commercial partnerships; we need a strong, dedicated workforce that can clearly articulate what needs to be done and then they make sure it gets done right. We need healthy NASA centers that fully utilize their unique strengths, and work together to turn the *Vision for Space Exploration* into reality. As we gear up to accelerate CEV and CLV, all NASA Centers have been assigned enhanced roles and responsibilities to accomplish our exploration goals.

Setting Priorities Within Exploration Systems

On September 30, 2005, NASA provided a detailed FY 2005 Operating Plan update to all of the Committees in Congress which oversee NASA. Within this Operating Plan update, we outlined how the Agency would accelerate development of the CEV and the Crew Launch Vehicle (CLV) while remaining within planned budget guidance for Exploration Systems.

In the FY 2006 Budget Amendment, $292 million was identified as moving from R&T activities into the Constellation Systems program for CEV and CLV acceleration. Following the results of the ESAS, an additional $493 million is identified to be redirected from R&T activities to CEV and CLV. This yields a total shift from R&T to Constellation in FY 2006 of $785 million, relative to original plans for FY 2006.

CEV and CLV development requirements directly drive the content of ESMD's R&T components. This includes Exploration Systems Research and Technology (ESR&T), Human System Research and Technology (HSR&T), and Prometheus. Focus is shifted from advancing technologies for long-term requirements to directed research and maturing technologies for near-term use. As a result of these R&T requirements, ESMD is undertaking transitional activities within the ESR&T and HSR&T programs to suspend expenditures on specific R&T tasks that will not be continued in FY 2006. FY 2006 funding made available as a result of this transition will be redirected to the Constellation Systems program to enable timely development of the CEV and CLV. Realignment of ESR&T tasks is necessary also to address the technology development priorities for lunar exploration. New technology development activities will be initiated beginning in FY 2006 and will be performed by NASA Centers. Major new work in ESR&T beginning in FY2006 includes development of variable thrust rocket engines that use methane and liquid oxygen propellants, thermal protection system materials, and an auxiliary power system for

the CLV. Realignment of HSR&T tasks will shift focus on primary crew health and performance for exploration missions, while reducing tasks in Life Support and Habitation, Human Health and Performance, and Human Systems Integration. Additional detail is below.

- *Human Systems Research and Technology (HSR&T):*

  NASA is focusing HSR&T funding on program elements that mature technologies needed to support lunar sortie missions and ISS access, while reducing program elements targeting longer-term or lower priority needs. As NASA concentrates the use of the Shuttle on ISS assembly, some ISS utilization will be deferred. As a result, transitional action is being taken now to reduce and/or discontinue approximately 34 contracts and activities previously planned at $344 million in FY 2006. After termination costs and buyouts, these actions will yield $243 million in FY06 that will be applied toward accelerating the CEV and CLV.

- *Exploration Systems Research and Technology (ESR&T):*

  NASA is realigning projects to support the ESAS recommended architecture requirements. This realignment has resulted in a focused and phased requirements driven R&T program in which some projects are curtailed, some are adjusted, and some are added. Ongoing projects are streamlined to deliver Technology Readiness Level 6 capabilities when needed (system preliminary design review) so as to enable the CEV, launch systems, and lunar lander development schedules. Examples of technology projects focused on the near-term include ablative thermal protection and liquid oxygen-methane propulsion for CEV. Additional work will be phased in after the first few years for lunar lander propulsion systems and nontoxic power and reaction control for launch vehicles. Funding for technologies applicable to lunar surface systems, such as in situ resource utilization (ISRU), are deferred and phased in only during the out years. Discontinued, descoped or delayed technology projects include nanomaterials, inflatable structures, large-scale solar power, intelligent robotic systems, in space assembly, Mars mission specific technologies, and electric propulsion. Transitional action is being taken now to discontinue plans for 80 tasks and activities, previously planned at $206 million in FY 2006, which do not directly support ESAS architecture or schedule requirements. These actions will yield $174 million in FY 2006 that will be applied towards accelerated development of CEV and CLV.

- *Prometheus Nuclear Systems and Technology (PNS&T):*

  Prior to the completion of the ESAS study, NASA was planning to restructure the Prometheus Nuclear Systems and Technology (PNS&T) program to prioritize NASA's nuclear technology development efforts to provide power on the surface of the Moon for a lunar outpost. ESAS results indicate that, given resource constraints, surface nuclear power systems to support potential long-duration stays on the Moon will not be required until after 2018. Nuclear propulsion will not be required until planning for Mars missions begins in earnest. The result of the findings is a total reformulation in the nuclear program, deferring all work until it is needed, yielding $76 million in FY 2006 to accelerate development of CEV and CLV. Funding at these lower levels also assumed that remaining JIMO project activity was concluded at the Phase A Project Mission Systems Review milestone and that support for Prometheus by the DOE's Office of Naval Reactors will not continue. NASA has contacted the Office of Naval Reactors to initiate planning for termination actions on activities covered by the Memorandum of Understanding between NASA and DOE (National Nuclear Security Administration-Naval Reactors) regarding Civilian Space Nuclear Reactors. The bulk of the remaining FY 2005 and projected FY 2006 funds for this activity will be spent on termination costs. NASA will continue a low level of funding for key, high-priority, nuclear system R&T issues, with longer-term plans to increase funding in the future, as the need for long duration lunar and Mars applications approaches.

Status of Returning the Space Shuttle to Flight

The first step in pursuing the exploration vision is to return the Space Shuttle safely to flight in order to complete the assembly of the ISS, and then to retire the Shuttle from service by the end of FY 2010. Following the loss of foam insulation from the Space Shuttle's External Tank (ET) during the launch of Discovery (STS–114) in July, we established a "tiger team" to review various manufacturing aspects of the insulation and implications that the foam loss will have for future vehicles.

The team reviewed the STS–114 environments, processing steps, and materials. Our engineers have identified several potential causes for the foam loss. Although a single specific cause cannot be isolated, these same engineers have developed fixes to control all potential causes, and Shuttle workers will likely replace, using more carefully controlled procedures, the areas of insulation on the external tank where foam came loose during the July launch. Plans to inspect and repair the tanks in Michoud are complete, and the repair work has already begun.

The next Shuttle mission, also on Discovery, will be the second test flight in the Return-to-Flight sequence. While we have not set a specific launch date, we are using the May 3 to 23, 2006, launch window as a target for work to prepare Discovery for the mission. Factors contributing to the decision to target the May launch window include outstanding tank work and the effect on the NASA workforce by Hurricane Katrina. NASA's Michoud Assembly Facility near New Orleans and the Stennis Space Center in Mississippi were in the storm's path, and much of their workforce has been displaced by the storm. Since external tanks are manufactured at Michoud, work there is crucial. Approximately 25 percent of the workforce is back on the job. If improvements to transportation and infrastructure go as planned, the full staff could be back at work in December.

Status of Katrina Recovery and Repair

As a result of Hurricane Katrina, significant damage was sustained by NASA's Stennis Space Center (SSC), Mississippi, and Michoud Assembly (MAF), Louisiana. SSC is NASA's premier rocket propulsion testing site. The Center also hosts the NASA Shared Services Center (NSSC) and a number of other federal agencies on its campus. MAF, near New Orleans, is NASA's manufacturing site for the Space Shuttle program external tanks. NASA estimated that initial Katrina-related response and recovery costs through October, 2005 would be approximately $100 million. NASA has established a Unique Project Number (UPN) within the Space Shuttle budget, to record and track all expenditures. In the September Operating Plan update, NASA identified $100 million in available carryover funds—$15 million within the Shuttle Life Extension Program and $85 million within International Space Station Cargo/Crew Services funding—that has been redirected to the UPN for these immediate Katrina-related costs. On October 28, the Administration forwarded to Congress a FY 2006 emergency reallocation and rescission request that includes a request of $324.8 million to support NASA Hurricane Katrina response and recovery needs through at least May 31, 2006. The requested funds will be used to meet recovery needs at SSC and MAF including: repair and replacement of real property, Space Shuttle external tanks and external tank support equipment, and communications and IT infrastructure; environmental remediation; emergency operations (diesel fuel for power generators, debris removal, etc.); and, satellite and aircraft imagery for evaluation of hurricane damage.

International Space Station (ISS) Status and Plans

Earlier this year, we established a team known as the Shuttle/Station Configuration Options Team (SSCOT) to evaluate options for the assembly and utilization of the ISS, taking into account the plan to retire the Space Shuttle by 2010 while honoring US commitments to the Space Station International Partners. The Team also considered that Space Shuttle flight rate planning must account for the limitations of the Shuttle that became apparent after the loss of *Columbia,* namely that NASA's ability to successfully conduct 28 Shuttle flights by 2010 was no longer technically feasible.

The results of the study have been reviewed by the Space Operations Mission Directorate and other NASA offices, and we have initiated discussions with the ISS International Partners.

- *Key Elements of NASA's Plan for Space Station:*

  NASA's proposed plan, subject to the normal budget and appropriation process, as well as ongoing return-to-flight considerations, is to fly the Shuttle in a disciplined, measured fashion, and to retire it by the end of FY 2010. The flights to the ISS would be ordered to provide the necessary infrastructure for the International Partner modules first, followed immediately by the Partner laboratories. Maintenance and logistic flights for sustainability are at the end of the sequence. The order and flight strategy is as important a consideration as the specific number of flights.

  The plan includes the launch of key NASA-provided infrastructure elements and other capabilities to enable a potential six person crew and meaningful utilization of the ISS. NASA has determined, however, that its exploration re-

search objectives no longer require the Centrifuge Accommodation Module that is being developed for NASA by JAXA under a barter arrangement.

This proposed approach would accommodate almost all of the International Partner elements currently planned for launch to the ISS, with the notable exception of the Russian Solar Power Module. NASA is prepared to immediately engage in detailed bilateral discussions to establish mutually beneficial arrangements to accommodate the proposed change.

NASA senior officials have been meeting with our key International Partners to discuss this approach, and the Partners have agreed to conduct a series of multilateral discussions to receive and assess the full details of NASA's proposed plan and the Partners' priorities in preparation for an anticipated Space Station Heads of Agency meeting in the January 2006 timeframe.

Recently, the Multilateral Coordination Board (MCB) convened to discuss the proposed configuration and assembly sequence and tasked the Space Station Control Board (SSCB) to assess the technical aspects of this new approach. The MCB is the senior ISS management forum responsible for oversight of all ISS development, operations and utilization activities, with high-level representation from NASA, Russia, Europe, Japan and Canada. Following these detailed discussions, the partnership will be ready to meet at the Heads of Agency level.

Aeronautics Research

Dr. Lisa Porter was recently selected as Associate Administrator to lead NASA's Aeronautics Research Mission Directorate. In that role she has begun the process of reshaping NASA's Aeronautics research program allowing the Agency to take responsibility for the intellectual stewardship of the core competencies of Aeronautics for the Nation. This will require us to reinvest in the Agency's in-house expertise to ensure that we retain the world-class skills, knowledge, and facilities needed to guarantee our nation's ability to consistently contribute world-class innovation to aeronautical challenges, both civilian and military.

The reshaped aeronautics program will strengthen our partnerships with the Department of Defense (DOD) and Federal Aviation Administration (FAA), capitalizing on each agency's unique capabilities and resources to strengthen the Nation's leadership in aeronautics. Our partnership with DOD will include close collaboration to establish an integrated national strategy for management of the Nation's most vital wind tunnels. As a result, NASA and DOD will work cooperatively to consider the impact of any decisions regarding the management of each agency's respective wind tunnel facilities. We will forge new partnerships and continue to benefit from partnerships built in the past with academia and industry. Industry will be able to rely on us to invest in the "seed corn" that is the critical ingredient in revolutionary technological advancement.

As a first step, NASA is reshaping the three major programs within the Aeronautics Mission Directorate. The previous Vehicle Systems Program is being renamed the Fundamental Aeronautics Program in order to reflect properly its new focus on fundamental aeronautical sciences. Within Fundamental Aeronautics, and consistent with direction we received from the Congress, we will re-establish the Agency's dedication to the mastery of core competencies in subsonic, supersonic, and hypersonic flight. We will create projects that provide continual, long-term investment in the fundamentals and that build upon that investment to develop system-level, multi-disciplinary capabilities that will enable both the civilian and military communities to build platforms that meet their specific needs. As part of our investment in fundamental aeronautics, we are positioning the program to continue important long-term research activity in FY 2006 that preserves the core competencies in rotorcraft and hypersonics, drawing upon NASA's critical in-house expertise. We are transforming the Aviation Safety and Security Program into the Aviation Safety Program, where we will focus research on safety areas that are appropriate to NASA's unique capabilities. Projects in Aviation Safety will address integrated vehicle health management, resilient aircraft control, intelligent flight deck technologies, and aging aircraft. The Airspace Systems Program is being realigned to directly address the air traffic management needs of the Next Generation Air Transportation System (NGATS) as defined by the Joint Planning and Development Office (JPDO), pursuant to Public Law 108–76.

Leading scientists and engineers from the NASA field centers participated in workshops in September and October to lay the foundation for a technical plan to reshape the Aeronautics Research program. As the year progresses, this technical plan will be guided by the National Aeronautics Policy that is being developed by Office of Science and Technology Policy and NASA in collaboration with other agency partners. (Dr. Porter is co-chair of the National Science and Technology Council's

Aeronautics Science and Technology Subcommittee.) In addition, the National Research Council is currently conducting a decadal survey for aeronautics, which will also provide inputs to our plan.

Maintaining a Robust Science Portfolio

As NASA moves forward to implement the *Vision for Space Exploration,* science will remain a major element of NASA's overall portfolio. During the past year, the science program has yielded many exciting results. The Cassini spacecraft has had close encounters with a number of Saturn's diverse moons and returned many exciting results, including images of the mysteriously sponge-like cratered moon Hyperion. Coordinated observations of celestial gamma ray bursts by four NASA spacecraft and ground-based observatories showed that these brief bursts of radiation, among the most powerful explosions known, are emitted when a black hole swallows a neutron star. Solar physicists used data from European and NASA space observatories to improve our understanding of the role of electric currents in solar flares, which can disable satellites and will pose a threat to future astronauts. The Deep Impact spacecraft successfully collided with Comet Tempel 1 causing a massive explosion on the comet's surface. The debris released by the force of this impact will be used by scientists to study the formation of the solar system and the structure and composition of comets. The Mars Reconnaissance Orbiter was successfully launched and is on its way toward a March 2006 arrival. On a more urgent note, NASA teamed with other federal agencies and used its aircraft and satellite remote sensing systems to track Hurricane Katrina's winds and then to evaluate the damage and flooding caused by the storm. The Hubble Space Telescope was used to search for oxygen-rich minerals on the Moon that might be useful for long-term human presence there. Our science program will continue to be a major emphasis of the Agency, and we look forward to comparable future results from the science portfolio.

To continue this agenda of discovery, the science budget outlook promises a healthy and vigorous program. The FY 2006 President's budget showed a slight decrease of less than one percent in the budget for NASA's Science Mission Directorate, relative to the FY 2005 budget, but this was attributable to adjustments to support reducing the federal deficit and other National priorities. NASA's science budget was not cut to serve the needs of the human exploration program.

Within the science program, NASA seeks to maintain a robust portfolio of investment over time across the several disciplines in the Earth and space sciences. Beginning with the baseline of existing programs and recent strategic planning, we set future directions by factoring in recent scientific progress, Presidential initiatives, and science community advice. Beyond these broad considerations, choices between programs in a discipline can be driven by technology readiness and partnership opportunities that can leverage NASA's investment.

As we continue to expand the frontier of scientific knowledge of the universe, however, we recognize that NASA cannot afford to take advantage of all deserving opportunities. In making choices within these constraints, we recognize the need to change the emphasis of the science portfolio. For example, it had been planned to allocate, in FY 2006, a very substantial increase in funding to robotic Mars exploration in future years. We have revisited these plans, and are adjusting our portfolio to increase emphasis on Earth and solar science as an important component of the science program. The value of Earth science and applications from space has been highlighted during the recent hurricanes and their aftermath. Some of the re-allocated resources are also targeted for urgent needs in the NASA astronomy program. These budget adjustments are internal to the science program and will not affect NASA's proposed spending on exploration or aeronautics.

In defining and executing specific science program activities, the prime consideration remains excellence. NASA will continue to look to the National Academies for advice on scientific priorities, using, for example, discipline decadal surveys. These are now available in all of the areas of space science and a corresponding major Academy study is currently underway for Earth science. We expect the latter to be completed in fall of 2006. NASA will also continue the practice of selecting investigations via merit-based peer review of competitive proposals received in response to open solicitations, and investigators at the NASA Centers will continue to be able to compete against other investigators for support for their own research programs.

Looking beyond the science program itself, we believe that the Science Mission Directorate will play an important role in implementing the Vision. This exploration program is not premised on or justified exclusively by science, but we expect enhanced opportunities for scientific investigation to be a significant aspect of it. As a result, we are working to establish the right interfaces and linkages between pro-

gram planning in the Science Mission Directorate and the Exploration Systems Mission Directorate.

NASA Workforce

Although the overall NASA budget has increased in recent years, the NASA workforce has been impacted by significant budget reductions in our aeronautics programs, cancellation of programs, and investment changes to the research and technology portfolio of the Exploration Systems Mission Directorate. We have taken specific actions to try to alleviate this problem. For example, starting in November 2004, NASA implemented employee buyouts to rebalance the workforce and in January 2005 established hiring guidelines to emphasize filling vacancies from within the Agency. We are also making significant changes that will help ensure that NASA's Centers have a productive future. Contractors will continue to play a key role, but we need to ensure that the Federal Government maintains the in-house intellectual core capacity to sustain NASA's exploration, science and aeronautics missions. Our goal is to ensure that NASA Centers are productive contributors to the Agency's agenda and that we have the people and tools necessary to accomplish the long-term goals of space exploration. With that in mind, we will be making changes at Headquarters as well.

In September, NASA initiated an Institutional Requirements Review (IRR) the scope of which includes corporate G&A, corporate service pools, and all Headquarters-based operations. Our goals are to keep corporately funded requirements within overall corporate budget guidelines, reduce the total workforce at Headquarters commensurate with its appropriate role and overall size of the Agency, and consolidate required personnel at the Headquarters building. We aim to (1) gain operational efficiencies; (2) align ourselves to a management model that has Headquarters in charge of architecture, strategy, policy, compliance, and general management with field Centers executing programs and projects; and (3) set an example for the rest of the Agency of the willingness of Headquarters to make hard decisions that benefit NASA in the long run.

Assuming we can achieve additional buyouts in the next few months, NASA has approximately 950 civil servants in the field that are not currently assigned to NASA programs in FY 2006. We will continue to address this problem and structure the workforce to ensure the success of the exploration vision, as well as NASA's other missions in science, aeronautics, education, space operations and exploration. However, changes to our skill mix and, therefore, the workforce will be required.

The NASA Office of Human Capital continues to work with center management on the workforce strategies. We will continue to identify center work assignments based on our strategic planning for the exploration systems. We are in the planning stages of offering a final buyout program to employees.

If we are unable to cover all of the NASA civil service positions, NASA is planning to conduct a Reduction in Force (RIF). Our Office of Human Capital is working with human resource offices at the centers to ensure readiness for a RIF, should it become necessary. However, a RIF is a last resort, and we will exhaust all other reasonable possibilities before undertaking such an action.

With changes to NASA's mission it is important that we manage our workforce issues to ensure that we have the right skill mix to successfully execute the vision for space exploration and maintain the important work in other areas such as our aeronautics, space operations and science portfolios. We will have an integrated, Agency-wide approach to human capital management.

NASA Authorization Bill for 2005

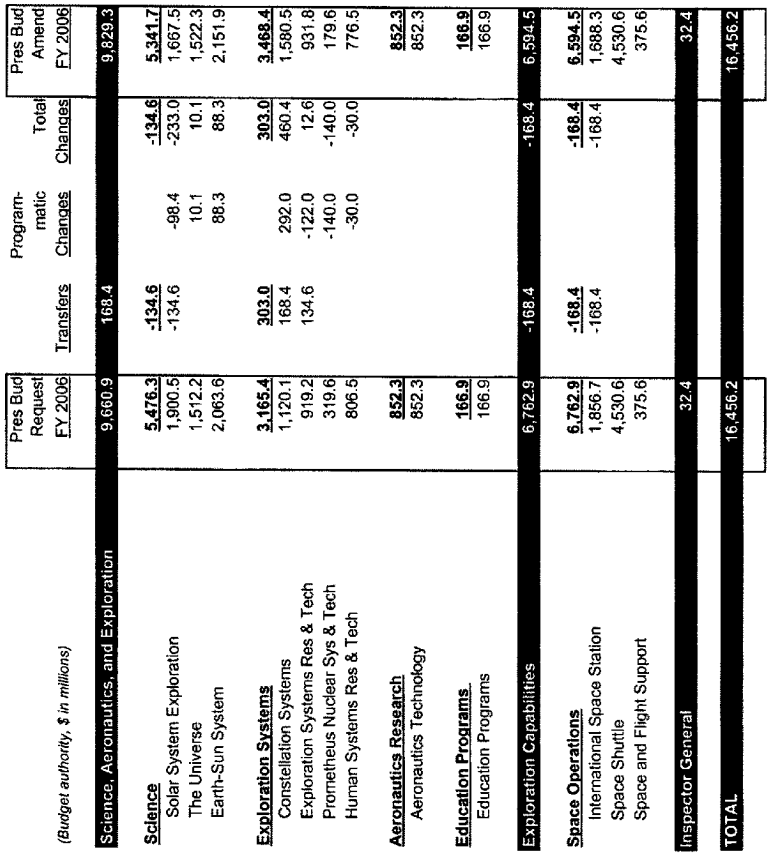
The House and Senate have passed two differing versions of the *National Aeronautics and Space Administration Authorization Act of 2005* (H.R. 3070 and S. 1281), and we understand that conferees may meet soon to resolve the differences between the two versions. We will soon be sending the Committee a letter outlining NASA's views with respect to the bills for Members' consideration during this conference.

NASA applauds both bills' endorsement of the *Vision for Space Exploration,* and the incorporation of a number of the legislative provisions the Administration included in the proposed NASA authorization bill submitted to Congress. Both bills provide many of the policies and tools necessary to achieve the fundamental goal of the Vision, i.e., the advancement of U.S. scientific, security, and economic interests through a robust space exploration program. While we find much to support in both bills, we continue to have serious concerns regarding several provisions in each bill that need to be satisfactorily addressed prior to final enactment of reauthorization legislation, and look forward to working with the Committee to resolve these issues.

Conclusion

In the months ahead, I am confident that we will achieve steady progress in reaching our exploration objectives—one mission, one voyage, and one landing at a time. I am convinced that in the ways we are attacking the challenges presented by the *Vision for Space Exploration,* we are setting the stage for a space program that will increase our opportunities to advance scientific knowledge and expand our horizons.

Once again, thank you for the opportunity to testify today. Mr. Chairman, and Members of the Committee, I would be pleased to respond to any questions.



(Budget authority, $ in millions)	Pres Bud Request FY 2006	Transfers	Program-matic Changes	Total Changes	Pres Bud Amend FY 2006
Science, Aeronautics, and Exploration	9,660.9	168.4			9,829.3
Science	**5,476.3**	**-134.6**		**-134.6**	**5,341.7**
Solar System Exploration	1,900.5	-134.6	-98.4	-233.0	1,667.5
The Universe	1,512.2		10.1	10.1	1,522.3
Earth-Sun System	2,063.6		88.3	88.3	2,151.9
Exploration Systems	**3,165.4**	**303.0**		**303.0**	**3,468.4**
Constellation Systems	1,120.1	168.4	292.0	460.4	1,580.5
Exploration Systems Res & Tech	919.2	134.6	-122.0	12.6	931.8
Prometheus Nuclear Sys & Tech	319.6		-140.0	-140.0	179.6
Human Systems Res & Tech	806.5		-30.0	-30.0	776.5
Aeronautics Research	**852.3**				**852.3**
Aeronautics Technology	852.3				852.3
Education Programs	**166.9**				**166.9**
Education Programs	166.9				166.9
Exploration Capabilities	6,762.9	-168.4		-168.4	6,594.5
Space Operations	**6,762.9**	**-168.4**		**-168.4**	**6,594.5**
International Space Station	1,856.7	-168.4		-168.4	1,688.3
Space Shuttle	4,530.6				4,530.6
Space and Flight Support	375.6				375.6
Inspector General	32.4				32.4
TOTAL	16,456.2				16,456.2

DISCUSSION

CEV ACCELERATION

Chairman BOEHLERT. Thank you very much, Mr. Administrator.

Well, the challenges that have—you know, I am reminded of, you know, the Academy Award winning actor who uttered the famous lines: "Show me the money." I think if all of us who expect you to put—pull the rabbit out of the hat and we are able to give you a path to the money you wanted, I am confident you could use it wisely and accomplish everything we want, but I don't know where the hat is, let alone the rabbit. And I do know the money is a challenge.

So I ask you this. What are the consequences if we start down a path to accelerate CEV and then find out that we don't have the money in fiscal year 2008 to remain on that path? Are we worse off than if we just set 2014 as the date today? And parenthetically, just let me say, I think CEV acceleration would be great, but only if it doesn't eat into other vital programs that I also think are very great.

Dr. GRIFFIN. Clearly, the best thing to do for any program is to pick a date that is achievable and to provide the funding as it is required in the different phases of the program consistent with the overall ceiling that is provided. We believe we have budgeted adequately for the CEV. We believe that if the President's budget is approved, that it can be delivered in 2012. We believe that if it is delayed further, we risk losing critical competencies between the end of Shuttle retirement and the onset of operations of the CEV. We also risk taking America out of manned space flight for four critical years following the completion of Station assembly at a period of time when the programs of other nations are in their ascendancy.

I believe this to be strategically the wrong thing to do, and so I have stated that replacing the Shuttle with an equivalent capability through the use of the CEV as soon as possible after Shuttle retirement is our real highest priority. And if other adjustments need to be made to respect that priority, I would respectfully recommend that those adjustments be made.

Chairman BOEHLERT. We don't now have the money in the projections ahead to pay for Shuttle's CEV acceleration, so what happens if we get started on CEV and have to slow it down? What are the consequences of that?

Dr. GRIFFIN. If we start on CEV at a certain pace and then have to slow it down, we will become less efficient in that program and will—absolutely will cause it to overrun.

Chairman BOEHLERT. So get back to the basic question. If—are we being too ambitious right now in setting the 2012 date, given the circumstances that exist that I think we all agree are there?

Dr. GRIFFIN. Sir, I think that our plan is sound. I think our plan for CEV development includes adequate cost reserves against unknowns. We are working to understand and contain Shuttle costs, and we propose maintaining a robust program of space science while we complete this CEV. All plans have uncertainty.

Chairman BOEHLERT. Well, I understand that, but——

Dr. GRIFFIN. And we have advanced to you the best plan that we have been able to craft.

STAFFORD-COVEY MINORITY REPORT

Chairman BOEHLERT. The Stafford-Covey Report, and I have had some discussion with you outside of the Committee hearing room on this. The Stafford-Covey Report included several minority reports. And one minority report stated that NASA has not yet learned the lessons of the past. And I know you examined that minority report very carefully and have been addressing that in your public statements. Do you agree with the conclusions of that minority report specifically? And are there observations in the minority report that you don't agree with? And the changes you have made in the personnel, do you think that would satisfy those who were—identify with the minority report that you get it and you are now moving in a direction, on a course that they think is prudent for you to follow?

Dr. GRIFFIN. There are many questions there. I will try to answer them. Remind me if I fail.

I read—I believe, the particular minority report you are talking about is the 19-page report by authors Dan Crippen and Chuck Daniel and——

Chairman BOEHLERT. That is exactly right, sir.

Dr. GRIFFIN.—several others. These are people whom, by and large, I know and respect. I read their report very carefully with yellow highlighters and underlined marks and also conveyed the report to others whom I deeply respect and asked for their comments. When I had done all of those things, I found that, while I could not agree with each and every specific remark in the report, broadly speaking, I did believe that it was correct. It rang true are the words that I would say. And others agreed with me. It rang true.

Accordingly, I discussed it in detail with our new AA for Space Operations, Bill Gerstenmaier. Bill also felt that, broadly speaking, the report rang true. We have shredded that report out into—there are much pros and then there are many actionable specifics. We have shredded out the actionable specifics, and we have put together—we are putting together, I should say, a plan to deal with those. And when we have that ongoing, we will be happy to review that with you or with your staff.

Separately, I have chartered a team, a separate independent team, much like the Exploration Systems Architecture team that you discussed earlier today, to look at NASA safety and mission assurance from the broadest possible perspective and across the entire agency. This special team is being run out of our program analysis and evaluation directorate. They will report directly to me, and they will take a look, and again in the broadest possible sense, about what it means to have safety and mission assurance at NASA.

And so those—that is the two-pronged attack I have on the issues raised by the minority report.

I would also say that, in some cases where particular friends of mine on—who authored that report have been contacted, that they have been very positive. I don't want to put words in other people's

mouths, because I have had that done to me and don't appreciate it, but broadly speaking, I would say the people I have talked to on the minority Committee strongly approve of the people that we have put in place in running the mission directorates at NASA. I hope that that will continue.

Culture change takes a long time. When we lost *Challenger,* there were management culture issues in play. When we lost *Columbia* 17 years later, there were management culture issues in play, and in some cases, they were the same issues. I have, in fact, reorganized the engineering and programmatic structure of how we do business in NASA in order to obtain the kind of independent, technical, authoritative excellence that we want. I have made technical excellence proven in the field a non-negotiable criteria for having a high-level management position in NASA from this day forward.

I believe that these changes, although they need time to take effect, when, and as they take effect, will bring us the kind of National Aeronautics and Space Administration that you and I and all of us want to see.

Chairman BOEHLERT. I will honor your request, Mr. Administrator; I will no longer use baseball analogies. You just birdied that one.

Dr. GRIFFIN. Thank you, sir.

Chairman BOEHLERT. Mr. Gordon.

Mr. GORDON. Thank you, Mr. Chairman.

SERVICING OF THE HUBBLE SPACE TELESCOPE

Dr. Griffin, listening to your testimony, I have a couple of quick—one thought and one question.

I—your—the comment that the CEV, that you were prepared to do whatever it takes to get it up and going, I think, is a dire warning to the rest of NASA. I am concerned about that, but I—let that warning, I guess, go out to everyone.

The question, also in your testimony, I—well, I thought it—the servicing of the Hubble was pretty much a done deal, but you said that was still in play. Is that still in play whether you are going to do it or not because of budgetary reasons, or because there are still some questions as to the mechanics of the ability to do the job?

Dr. GRIFFIN. Let me answer the second question first. The Hubble decision, I have not changed my thoughts or my wording on that since the day of my confirmation hearing. If NASA can technically perform a Shuttle servicing mission to Hubble, it will be done.

Mr. GORDON. Okay. So it is a high priority then?

Dr. GRIFFIN. Right. It is——

Mr. GORDON. Okay.

Dr. GRIFFIN.—the highest—frankly, it is my highest priority for the Shuttle program.

Mr. GORDON. Good. I just misunderstood that.

And when do you think you will make a decision on the technical aspect of that?

Dr. GRIFFIN. I have already said, we needed the second—we need the two return-to-flight missions, because, following the loss of *Columbia* and the return-to-flight sequence, we have new entire con-

straints on usage of EDA time, because some of it may need to be preserved for inspections and repairs, like we did on the last mission. We need to understand the full operating profile to know if we have time in the mission sequence——

Mr. GORDON. Okay.

Dr. GRIFFIN.—to perform an effective——

Mr. GORDON. Thank you. I want to move on, but thank you, sir.

Dr. GRIFFIN. Thank you.

Mr. GORDON. So we are still in sync, thanks.

Dr. GRIFFIN. Yes, we are.

Mr. GORDON. Dr. Griffin, I would also like to follow-up with some more questions regarding your current budgetary situation.

BUDGET SHORTFALL

The fiscal year 2006 budget request that NASA submitted to Congress included a five-year budgetary run-out through fiscal year 2010. As of now, how much are you short relative to what you will need through fiscal year 2010?

Dr. GRIFFIN. I am not trying to evade your question. I am not sure I understand—I am not sure I fully understand it.

The 2006 budget request had a run-out through 2010——

Mr. GORDON. Yes.

Dr. GRIFFIN.—through fiscal year 2010.

Mr. GORDON. And it is my understanding that to do what you are proposing to do, you are going to be, as I think—well, our Chairman earlier said he thought it was in the $6 billion range. A conservative estimate is $3 billion——

Dr. GRIFFIN. I understand your question.

Mr. GORDON. So what is your opinion as to that shortfall?

Dr. GRIFFIN. Relative to the 2006 budget request, we are, I would say, several billion dollars short in the Shuttle operations line. I would remind the Committee that the out-years projections for Shuttle operations costs, when they were made, at the time, a couple of years ago now, were labeled as placeholders, that we did not fully understand—on the Administration side, we did not fully understand what it was going to take to retire the Shuttle in a disciplined and orderly and effective way in 2010. We have now looked at that over the summer as part of the Shuttle Station operations exercise. We believe we understand that. And it is several billion dollars.

Mr. GORDON. Would it be fair to say in the $3 billion to $6 billion range? Is that——

Dr. GRIFFIN. I would say the $3 billion to $5 billion range.

Mr. GORDON. $3 billion to $5 billion range. Okay.

Dr. GRIFFIN. And now let me also add, we are—that is an estimate. We are not just taking that as a for granted. We are not taking it as a given. We are scrubbing the program hard. We are doing that today. We were doing it yesterday. We will be doing it next week. We are looking for savings in the Shuttle program, because as we retire the Shuttle, of course we want to put as much money as necessary to operate it safely but no more. But where we are today in comparison to our run-out, as projected in the 2006 budget that you mentioned, we are a few billion dollars down.

Mr. GORDON. And then if I could follow up, and I do have some questions on that, are the components—or could you tell us what are the components of the shortfall? Does it assume an accelerated CEV delivery by 2012? And does it assume that NASA will essentially complete the assemblage of the Space Station by means of another 18 Shuttle flights? And how much of the budget shortfall can be allocated to the Shuttle program? And finally, with respect to the Shuttle, is it accurate to say that the fiscal year 2006 budget request prepared by OMB and NASA assumed productions in the Shuttle fiscal year 2008 to fiscal year 2010 funding requirement that did not have an analytical justification?

Dr. GRIFFIN. Again, sir, the 2008, 2009, and 2010 run-out for the Shuttle—we are okay in 2006 and 2007, as best as we understand it. The 2008, 2009, and 2010 numbers were, at that time, labeled as placeholders. We now have an analytical basis for that that we did not have at that time.

Mr. GORDON. Okay. Can you provide that to us for the record, because we don't have that? You don't have to do it right now, but I mean, will you——

Dr. GRIFFIN. Okay.

Mr. GORDON.—provide—or have your staff provide that to us?

Dr. GRIFFIN. Well, that——

Mr. GORDON. That analytic——

Dr. GRIFFIN. Those projections currently are part of our fiscal year 2007 budget formulation and, as such, are presently embargoed. So we will provide you what we can as soon as we possibly can, but——

Mr. GORDON. Well, again, I am not asking for 2007, and I understand the embargo, but rather the analysis for the 2008 to 2010——

Dr. GRIFFIN. Let me take your question for the record——

Mr. GORDON. Okay.

Dr. GRIFFIN.—and we will get back to you as soon——

Mr. GORDON. Good.

Dr. GRIFFIN.—as we possibly can.

Mr. GORDON. Okay. That is fine.

Dr. GRIFFIN. And I forgot your other questions.

Mr. GORDON. What are the components of the shortfall?

Dr. GRIFFIN. The components——

Mr. GORDON. Assuming an accelerated CEV delivery by 2012.

Dr. GRIFFIN. The shortfall is entirely within the Shuttle operations line. The exploration line in which the CEV is being developed closes. The exploration architecture was developed subject to the constraint that the budget must close within that line. The science budget line closes and aeronautics closes. So the shortfall of which you speak is entirely in the Shuttle line.

Mr. GORDON. We have a lot of folks interested today, so I will conclude my, at least, initial round now.

Mr. CALVERT. [Presiding] I thank the gentleman.

COMMERCIAL CREW AND CARGO

Dr. Griffin, the—as you know, the House just recently passed the Iranian Nonproliferation Act, as you mentioned earlier in your testimony, and it is—hopefully it will pass in the Senate. And hope-

fully, this dissipation by the Russians will continue until 2016. Obviously we didn't want to be there, but the Russians are in the critical path at this point. We need them in order to continue our mission to the International Space Station. But how soon do you really think we can get—or move away from our reliance on Russia and grow a United States industry in crew transportation and cargo resupply for the International Space Station. Do you think it is reasonable to expect something in the reasonable future? You probably understand that technology on that better than anybody.

Dr. GRIFFIN. Yes, sir, I do think it is feasible, and to that end, NASA has two initiatives in—one much larger than the other, in space flight over the coming years. The first that we have discussed maybe more than some of you want to is the CEV and trying to bring that online by 2012. And that system does have the capability. It is primarily designed to go to the Moon, but as with the Apollo and Skylab capability, it has a leave-behind or a residual capability to service the Station.

Our preferred outcome, however, for servicing the Station is to obtain crew—well, initially cargo supply and later crew rotation services through more arms-length commercial transactions. To that end, we will be subsidizing over the next—the five years of the budget run-out approximately a half-billion-dollar commercial cargo crew re-supply capability. I do believe that that kind of a financial incentive for purely commercial industry, not developed on a government prime contractor relationship will be sufficient to allow substantial providers to emerge.

Mr. CALVERT. Do you have any guesses as far as to how soon that can be done? Two years? Five years?

Dr. GRIFFIN. All entrepreneurs will tell you that if we just give them the money, they can have it the day after tomorrow. My honest technical estimate would be that their time frame will not be substantially quicker than the government CEV time frame, but that if they are successful, it will be at greatly reduced cost. So I would anticipate four or five years. I hope that industry, if put to the test, can do better, but I do not expect it.

FINANCIAL MANAGEMENT

Mr. CALVERT. You mentioned, also, we had a hearing last week, a joint hearing with Government Reform relating to the financial management at NASA. And your CFO Gwen Sykes was present, and I asked her a question, if NASA were held to the same rigorous accounting requirement that U.S. corporations face under Sarbanes-Oxley, would you, as NASA's CFO, sign off on the annual fiscal report, and her response was no. So I guess with that, when do you think that NASA will have its fiscal house in order to meet the same standards that we, in Congress, are requiring of corporate America?

Dr. GRIFFIN. I—first of all, let me say I strongly endorse the requirement that NASA be able to account for its funds at least as well as its contractors be required to do and am, you know, appalled, as with all of you, that we find ourselves in this situation. I have made it a priority since coming on board, and we have made progress. We have made progress, as measured by independent advisory teams to include one which is led by the Comptroller of the

OMB. We have made progress. We are not there yet. We will—I have already been advised before they even did the audit, that our auditing firm will—we will still be red this year. So they haven't yet done the audit, and they know that we are red. So it will not be this year. I hope that by 2008 we will be in good shape. That is my plan.

We are—we—I will record a certain amount of progress which has been made. I believe I have passed out to your staff this particular sheet, which shows that in June, in one of, I think, nine categories, counting here eight categories of financial management, we were red in two and yellow in four and green in only three. In July, we were red in one, yellow in four, and green in four. And today—well, as of August, we had no reds, three yellows, and the rest green. We are making progress. We really are. We are taking it seriously. We have added resources that I would rather spend on space craft, but first, we have to get our financial house in order.

We have responded to the 45 recommendations from the GAO. We have closed only three, but 19 are significantly on their way to closure, and we are responding to the balance. The remaining 23 we will respond to.

Outside advisors have said that our strategy is correct, the plan is correct. We just need to stay on course, and that is what we are going to do.

Mr. CALVERT. I appreciate that.

Next, I recognize the gentleman who is rarely in the rough, the Ranking Member, Mr. Udall.

Mr. UDALL. Thank you, Mr. Chairman.

It depends on the day of the week, frankly, whether I am in the rough or not.

SMALL BUSINESSES AND UNIVERSITIES

Administrator, let me again—great to have you here. I want to thank you before I direct a couple of questions at you in regards to the exploration architecture and some of the impacts on small business and universities. I commend your focus on Hubble. We have had conversations along these lines, and it is such a tremendous asset for NASA, for the country. And as we have discussed, the man on the street, the woman on the street know about Hubble, and there is such potential here across the board. So thank you for your attention to it and commitment to it.

We are talking about the exploration architecture and several contractors, small businesses and universities this week received notice that their systems research and technology contracts had been terminated effective immediately. And specifically, I am aware of three contracts in my District that total nearly $12 million that have been placed in that status just in the last week. And I am sure that my District is not the only one that has been hit hard by these cuts.

And so in that spirit of looking across the board, I want to direct a couple of questions to you.

You stated you want to strengthen your partnerships with universities, but the claim NASA is making is that the termination of these projects is necessary to allow for new technology development in NASA Centers, not in the universities themselves. And of

course, you have put forth the point of view that the Moon Mars initiative will not come at the expense of important science projects, yet I believe I can identify at least one terminated project in my District as performing fundamental life science research under human research and technology that happens to be useful for exploration as well. How do you explain the contrasting priorities? And what are NASA's plans under the exploration architecture to strengthen its work with universities and ensure that this initiative doesn't come at the expense of science programs, a question you have heard before but, nonetheless, a very, very important question?

Dr. GRIFFIN. Let me try to do my best.

We had, earlier on, before—for some reason, before we had developed an exploration architecture, we, at NASA, had put out a very broad—we cast a net very widely on our research and technology program, unfortunately, leading many firms and many researchers to believe that we could sustain all of those. In fact, the technology development and the research that we should be conducting should be oriented toward, in an appropriately timed phase way, those projects which we are actually doing. So when we finished developing the architecture, which the Chairman has very kindly praised for its efficiency, part of that efficiency means that we should limit our research and technology efforts to those things which support the requirements of that architecture. And that required canceling a number of things which we either did not need or did not need right now, given our overall funding priorities as a Nation.

Now I have run, for the Defense Department, a very large, multibillion-dollar technology program in the past. It is fun. I would love nothing more than to have within NASA the kind of money to run a broadly-based technology program. But given our—the many priorities we have in this Nation, and the priorities that the Administration has for domestic discretionary funding, we, simply, in NASA, are not, at this time, able to run that kind of a broadly-based technology program, and so we have winnowed the field to those things that we believe we can afford.

With regard to science, when I speak of science, I am speaking of the science being done in the science mission directorate, broadly speaking space, Earth, and planetary sciences and astronomy. And the human life science research of which you spoke is there to support human exploration. It seemed, to me, that it was getting the cart before the horse to be worrying about money for human or other life sciences when we could not assure ourselves the continued capability to be able to place people in orbit in the first place. So my priority became assuring that the United States would have as close to continuous capability to put people in space first and then conducting the research on them after that.

Mr. UDALL. As I mentioned, I think this is a fairness question, and it cuts across the country, and I don't think that my District is alone in suffering some of these proposed cuts.

What can we do to help these universities and businesses now that have been stranded? And do you have plans in the future to—in regard to this situation we face right now if those situations arise in the future?

Dr. GRIFFIN. For the next several years, I have tried to be very honest with the university department chairs and presidents who have contacted me, and in fact, including one in your District. I have tried to be honest with them. For the next several years, our resources that we can devote to Space Station will be utilized to assemble Space Station. And the focus on utilization of it for the next several years for research or technology or any other purposes will have to be minimized in favor of the priority of first getting it assembled. The priority after that, in keeping with the President's vision, is to provide a reliable, robust, sustainable successor to the Space Shuttle. And when we have those two components in place, a completed Space Station and a successor to the Shuttle, then we can begin to focus more heavily on utilizing the Space Station. But that will be several years in the future.

Chairman BOEHLERT. The gentleman's time has expired.

Mr. Rohrabacher.

Mr. ROHRABACHER. Thank you very much, Mr. Chairman.

I want to say hello to my old friend, Mike, and——

Dr. GRIFFIN. Hello, sir. Thank you.

AMENDMENTS TO IRAN NONPROLIFERATION ACT

Mr. ROHRABACHER. All right. I would like to, first and foremost, introduce to you, Mike, and to other Members of our committee, Mr. Koslovski, who is a member of Parliament from Russia, and joining us today, who is engaged in a meeting downstairs with the International Relations Committee. And I asked him to join us, because some of the questions that I had asked today will deal directly with Russian American space cooperation.

And to that end, I would like to ask you, Mike, about whether or not the legislation that we just passed through Congress will, indeed, permit us to have the type of cooperation we need with Russia, the amendments that we made to the *Iran Nonproliferation Act,* that will enable us to maximize our benefit of the Space Station, or is there something more that is going to be needed and why that is important.

Dr. GRIFFIN. I believe the legislation that you have passed will allow us to do what we need to do with Russia to continue our cooperation with them in the Station program. I think we are fine.

Mr. ROHRABACHER. Okay. So mission accomplished, as far as our end of it?

Dr. GRIFFIN. Yes. Yes, sir.

INTERNATIONAL COOPERATION

Mr. ROHRABACHER. Okay. That is short-term. The short-term was making sure that we could handle our obligations and—to the International Space Station Coalition in cooperation with the Russians and that we didn't find ourselves in a situation where Americans weren't going to be on a Space Station that we ended—that we paid for. That was the short-term.

In the long-term, I note that China and Russia are now entering into an agreement on space cooperation, perhaps an agreement that will result in Moon missions by the Chinese in cooperation with the Russians to the Moon. Doesn't this indicate—and doesn't

the fact that Russia went with—to Iran to do business indicate that since the downfall of communism in Russia, that we have not been engaged with Russia at a high enough level and it—and an intense enough level to prevent them from going into directions that are contrary to our national interests?

Dr. GRIFFIN. Well, that may be so. I don't believe it is up to me to define our national interests, but I will observe that other space-faring nations of the world, while not having the discretionary resources that we have to bring to bear on the subject, are very interested in the development, exploration, and the exploitation of space. And if we choose to lead the Space Station program, it provides ample evidence that we can lead and that we can form coalitions of nations to do great things in space. We can form partnerships and alliances. And heaven knows the United States would rather have partners and alliances than enemies and adversaries.

If we step away from a leadership role, if we are not willing to pledge the commitment, the resources, and the cooperation to assume a leading role in space, then others will fill that vacuum. And I think that is what you are observing. And I think it is incumbent upon us—as I said in my opening statement, Americans are a frontier society, and where there is a frontier, Americans must lead.

Mr. ROHRABACHER. But to achieve that goal—this is a very costly goal that we are talking about. Anything we do in space is very costly, especially dealing with space transportation, which you are trying to make up for right now with your plan. Won't Russia—isn't a cooperative effort with Russia vitally important for us to meet our own potential, because it brings down the cost?

Dr. GRIFFIN. Well, surely. And Russia has been an excellent partner. They have stepped up to the plate, as—to refer to a baseball analogy, they have stepped up to the plate on the Space Station in providing critical crew and cargo transportation services in the time that the Space Shuttle has been down.

All of that said, even a—even as significant a space-faring nation as Russia does not, at present, nor in the nearly foreseeable future, have the capability to provide the kind of heavy-lift, crew and cargo supply that the United States had been doing, can do, expects to do in the future, and must do, if it is to be done at all.

Mr. ROHRABACHER. Mr. Chairman, I would suggest that we keep an eye on the plans of what we—you know, our long-term plans in space and that if we are duplicating—if we are trying to build technology that duplicates what Russia can already do, that that is a waste of resources and actually a deterrent to the type of cooperation that will serve both of our countries and that we should utilize those resources—those things that Russia can provide to save money for us and use that money to develop new technologies that neither country has.

Dr. GRIFFIN. We are not duplicating capability.

Mr. ROHRABACHER. Okay.

Dr. GRIFFIN. And a certain amount of parallel capability and—offers a redundancy. When one is a committed space-faring nation, we need a certain amount of redundancy, because, as you have seen, we can have accidents. They have had accidents in the past. If we are single-string on our access to space, we are going to be in trouble.

Mr. ROHRABACHER. Thank you very much.

Thank you, Mr. Chairman.

Chairman BOEHLERT. The gentleman's time has expired.

I would point out to the gentleman that we are constantly working with the Administrator toward the objectives that you have outlined. We want to continue to promote international cooperation, but we want to minimize dependence on others for our core missions and capabilities.

With that, the gentleman, Mr. Honda, you are recognized.

Mr. HONDA. Thank you, Mr. Chairman.

And I welcome Administrator Griffin for being here.

Let me just cut real quickly to the chase.

CENTRIFUGE ACCOMMODATION MODULE

It feels like we are interrogating the Administrator for a situation that he had nothing to do with, but he has come in at a point where we needed him to sort of fix things and realign our projects based upon science rather than based upon the bottom line. I think that was the reason why I was—you needed to have him as Administrator.

And Mr. Administrator, I think that we have to accept the idea that it is not your budget. You didn't create the budget. You didn't create the allegation—or the appropriations. We did. And this Administration did. So you know, to my colleagues, if we are going to be pointing fingers, we have to look at the Administration and how we appropriated money to this program over the years. That is number one.

I think that President Kennedy didn't take this kind of approach when he challenged our Nation to put a man on the Moon. In fact, he noted, and I quote: "The facts of the matter are that we have never made the national decisions or martial and national resources required for such leadership. We have never specified long-range goals on an urgent time schedule and managed our resources and our time source to ensure their fulfillment." Kennedy understood that to get to the Moon, we needed to specify long-range goals and commit the resources that would be needed to achieve them. And he recognized that. And I quote: "If we are to go only halfway or reduce our size in the face of difficulty, in my judgment, it would be better not to go at all."

I think this is worthwhile going forward, and I think that we ought to put the resources out there. If we are saying, "Show me the money," then we have to show him the money so he can do the work that he needs to do. And our plan, as our colleague said on the other side, to meet our potential and to ask—to raise the question about relationship with other countries, how do we expect to get international partners to work with us on going to the Moon and Mars when we have broken our own agreements with them on the ISS? From what I hear, the Europeans and Japanese researchers are quite upset and do not intend to do any more collaboration with us due to the fact that we are throwing away billions of dollars they invested and 20 years of work by scientists and engineers. Why should they ever want to work with us again?

I think we ought to keep our word and our agreements and our treaties and also create more relationships with countries like Rus-

sia and China so that we can get there as global communities and make sure that we do this.

Having said that, Mr. Administrator, I have to, you know, really ask the question about the comments about the design of our Space Shuttle, the base—the design of our vehicle in absence of the biological and life sciences. I don't know how you sent up astronauts to the Moon or to Mars without that kind of research. And the Centrifuge issue is of great importance. And I would like to know, you know, how you, you know, align the kind of decision you are making when in a press conference about a month ago, you said, "In our forward plan, we do not take one thin dime out of the science program in order to execute this exploration architecture." However, the reality is that there have been major cuts to NASA's life science program as well as the elimination of almost all non-exploration-related scientific research on the International Space Station. How do you square that statement at the press conference with the actions taken by NASA to cut those activities?

The other question is many life science research communities have expressed alarm over NASA's decision to terminate the ISS Centrifuge program despite finding by the National Academy of Sciences that the absence of the Centrifuge would hinder NASA's ability to gain the fundamental knowledge essential to the maintenance of the astronaut health on long-duration space missions. Why did you decide to terminate the program, and how do you intend to answer the research questions that the Centrifuge was designed to address? And in response to one of Chairman Boehlert's questions, for the record, of last year's February 12 hearing on *Vision for Space Exploration,* NASA stated: "The Centrifuge Accommodation Module, CAM, still provides unique capabilities: the ability to simulate a full Mars mission, including, one, long-duration micro-gravity followed by a period of time at 3/8 gravity, two, followed by a more long-duration micro-gravity during which we can test bone loss, immunology, and other reactions to gravity changes. In situ dissections and detailed anatomy physiology after exposure to a fraction of gravity." This information is needed to determine the mechanisms of the observed changes and guide the development of new countermeasures, and I think, I suspect, the design of vehicles so that the folks who are in it are going to be taken care of or, you know, be healthy as they go on their long—along the trip.

I would like to submit more detailed questions for the record and get some responses to those questions. And if you don't mind trying to, with my three or four questions, formulate a response.

Dr. GRIFFIN. We certainly will take, of course, your questions to the record and answer them in full detail.

More broadly, let me say, first of all, that I certainly understand the rumors that are flying, but at this—the United States has not broken its agreements with the international partners and hopes not to do so. We have not done that.

The Centrifuge Accommodation Module is built for the United States as part of a barter agreement with Japan, and the flying or not flying of the Centrifuge is not an international partner agreement. It is a matter at our discretion. We have chosen not to fly it, because we do not have, in—looking ahead at the sequence, we do not have a Shuttle flight available in the sequence that can put

that module up. It is not a small module. And because the life science research that would be done on it is of a more fundamental nature, again, associated with fundamental organism behavior in fractional gravity. Now that is a very interesting subject. It is a key part of long-term life science research, but it is not immediately and directly associated with the health of astronauts in orbit or on the Moon in the near future.

Mr. HONDA. But how—to the Chair. How do you project physical impact and physiological impact, anatomical impact on humans without that study? This—the——

Chairman BOEHLERT. The gentleman's time has expired, but I will give the courtesy to the Administrator to answer the question.

Dr. GRIFFIN. Well, quite frankly, the best fractional gravity laboratory that we are going to have in the near future is the Moon. That will be a very—putting astronauts on the Moon and leaving them there for a lengthy period of time will tell us much of what we need to do about going to Mars.

Chairman BOEHLERT. Thank you.

The distinguished Vice Chairman of the Full Committee, the gentleman from Minnesota, Mr. Gutknecht.

Mr. GUTKNECHT. Thank you very much, Mr. Chairman.

COMMERCIAL PARTICIPATION

And Mr. Griffin, welcome to the Committee. I hope that you will make many appearances and brief us from time to time.

Sticking with the analogies, I am not going to—I am not here to tee off on you today, but I think there are some issues that need to be addressed.

First of all, my own feeling right now is that, especially after—in the aftermath of Katrina, I think Americans are somewhat skeptical of the Federal Government's ability to do the things that we claim that they can do. I also believe that they have become convinced that just simply throwing more money at problems does not guarantee acceptable results. I think taxpayers are rightly demanding more accountability. I applaud you for this matrix, but I have to say, not only your department, but most federal departments, to have this many red squares is just unacceptable. We certainly wouldn't accept that from corporate America, and American taxpayers should not accept it from any federal agency as well.

One of the things that—one of the first things you said was with the last launch of the Shuttle we saw chunks of the foam coming off, and you said we haven't completely solved the problem. I think we really deserve more candor. I mean, the truth of the matter is we haven't solved the problem. I mean, that is my perspective, and I think that is what we have to tell the American people.

Finally, and I guess this really does get at my question, we have met with private entrepreneurs who believe that they can launch vehicles and put payloads, and even human beings, into space at a fraction of the cost that it costs NASA to do the same thing.

I am wondering, as we go forward, can we look—I mean, the key words that Americans are looking for is they are looking for reform, they are looking for restructuring, they are looking for accountability. I mean, those are words that I think—they are not just words. I think they are things that the American people now expect

and demand more of from those of us in Congress but, more importantly, from federal agencies in general.

So I wonder if you could comment on your vision of how we look at ways that we can achieve the same results at significantly less cost, as at least some in the private sector believe that we can.

Dr. GRIFFIN. Yes, sir. I do understand that the public is skeptical of government programs. I would say that NASA's programs historically have an overwhelmingly high success rate and an overwhelmingly high positive impact. A very recent Gallup Poll conducted showed that, when asked if, at a budget level of less than one percent of the budget, did the public approve of or support the *Vision for Space Exploration,* which included finishing the assembly of the Station, replacing the Shuttle, and continuing on to the Moon and Mars, that over ¾ of Americans, you know, in a highly bipartisan way, supported those goals. And as you well know, NASA gets about 7/10 of a percent, not even a full percent, of the budget.

So I think public support of NASA, by recent measurements, is, frankly, at an all-time high.

With regard to improving accountability, again, I can only say I can't agree with you more. I could not agree with you more that our financial accountability must reflect that which we expect of our contractors, and I am working to restore it. My team is working to restore it.

With regard to foam, unfortunately, NASA flew 113 Space Shuttle missions before seriously attempting to reduce the rate of foam loss from its tanks to an acceptable level. It simply was not understood. It is unfortunate. It was not understood that a piece of foam could punch a hole in a wing. We then spent 2½ years trying to reduce that foam loss to nearly zero. We came close. We didn't quite get it. We believe, again, that we do understand it, and we believe that the fixes we have put in place for this next flight will solve the problem to the level that we need it solved. Foam loss will never be zero, but we believe we have fixes in place that will contain it to a level that is not harmful. That is on us to prove, and I understand that. I am out on a limb here. I understand we have that to prove to you.

With regard to entrepreneurs, I have been an entrepreneur a couple of times. It is fun. It is a very heady thing to do. And I am putting money at stake over the next several years to encourage those entrepreneurs to step forward and show what they can do. At the same time, NASA has mission requirements, government mission requirements laid on us that we cannot afford not to complete. So while I am enlisting the entrepreneurial community to step forward and help meet those requirements, we cannot stop work on the, admittedly less efficient, government systems in order that entrepreneurs either do or don't show up. It is just—that just doesn't work. So we have to have a core government capability to execute our mission. We will do that with the CEV following the Shuttle. And we will do everything in our power to encourage these entrepreneurial firms to step forward.

I might—I must say when you have never actually done anything, talking about doing it is a very easy thing.

Chairman BOEHLERT. The gentleman's time has expired.

Let me give you an assessment of the situation, as we now understand it. The bells are ringing. We have about 10 minutes to go, which will afford us the opportunity for Mr. Miller to get his questioning in. We are trying to determine from the cloakroom just what is going on. Apparently, the comity is dwindling and the comedy is on the asset. So we will find out, but we will go to Mr. Miller.

Our desire, Mr. Administrator, is to give you a pause to get a drink or something while we dash over and then come back and then continue.

Mr. Miller.

Dr. GRIFFIN. I am at the Committee's service.

Ms. JOHNSON. Could the gentleman yield?

Mr. MILLER. Yes.

NASA'S EDUCATIONAL ACTIVITIES

Ms. JOHNSON. Mr. Chairman and Ranking Member, thank you very much for this hearing. I apologize for being late. I had another engagement, and I can't come back after the vote; I have an amendment on the Floor.

But I did want to ask this question. I am sorry I missed a lot of your testimony, but I appreciate your leadership. And I really appreciate the research that NASA has participated in and the outcomes.

I am concerned about the building of the infrastructure for the future. And in that end, I would like to know what programs you still have going that would invest in some of the institutions and students to have exposure so that we can continue to build the workforce and the bright minds for NASA.

Dr. GRIFFIN. NASA's educational activities are an integral part of what we do in the Agency. This year, we are spending, I—if I recall the figure correctly, $367 million on education. And if I don't have it exactly right, I beg your indulgence, but it is a number very close to that. That is enough to buy a whole scientific space craft, easily, every year that——

Ms. JOHNSON. Could you send me a copy of your breakdown of where that goes?

Dr. GRIFFIN. We certainly can do that.

Ms. JOHNSON. I appreciate that.

Dr. GRIFFIN. We are in the process of—we—our education program has been criticized by many outside stakeholders in recent years. I have taken that into account, and we have put a new person, Mrs. Angela Diaz, in charge of that. We are crafting a new strategic plan for education. We are emphasizing commitments to university students, graduate research, exactly the kind of thing you are talking about. We are taking it quite seriously.

Ms. JOHNSON. Thank you very much.

I look forward to getting that soon.

Dr. GRIFFIN. We will be happy to provide that.

Chairman BOEHLERT. Thank you very much.

With that, we will take a temporary recess to go answer the call of the House and see what we can do to contribute to restoring comity, and then we will be back.

[Recess.]

Chairman BOEHLERT. Let us resume, and we will resume with the—Mr. Miller, you are up.

Mr. MILLER. Thank you, Mr. Chairman.

ENGINEERING AND SCIENTIFIC VALUE OF THE VISION

I recognize that you are—some of the other Members of the Committee would not feel cheated to have missed my questioning.

Mr. Griffin, my own preference for sports analogies is for basketball analogies, but I am afraid that George Tenet had ruined basketball analogies for politics for the next generation.

I want to follow-up on questions that Mr. Gordon asked and Mr. Udall asked and Mr. Honda asked and that I asked back in June about the science programs that had been eliminated, at least for the time being. And my concern about the vision, about returning first to the Moon is not that it is too ambitious but perhaps it is not ambitious enough. It seems that all of the justifications that we have discussed have to do with updating our engineering, the engineering that put us on the Moon a generation ago, and simply updating that to show we can do it again. But I have not gotten a strong sense of what the science is, if any, that we plan to accomplish on the Moon. You mentioned that the Moon was probably the best limited-gravity environment available to us, but what is the science that we plan to accomplish on the Moon by going there? Are we simply updating our engineering from the Apollo era, or are there scientific missions that we are going to perform on the Moon that we think would be valuable?

Dr. GRIFFIN. Sir, I think those are great questions, and they are at least two-prong, and let me take a whack at both prongs.

With regard to the engineering, no; we are not simply updating our engineering from the Apollo era, although some of that does need to be done. It has been, not one, but almost two generations since we, the United States, owned the kind of space transportation system that would allow us to go to the Moon.

The ability to go to the Moon, when one then adds the life support capabilities, becomes very close to that which we need to go to Mars.

So at the engineering level, it is not about the choice of destination for the moment. It is about the creation of a basic space-faring capability beyond low-Earth orbit. And then when you have that, you can go to the Moon, you can go to Mars, you can go to the near-Earth asteroids. And that is what we are about.

With regard to why go to the Moon along the way, I appreciate your point that it may not be ambitious enough and that we have been there before. But there is hardly anyone now still working in the space program who was part of those voyages. We have not invested in that avenue for almost two generations. So to set off immediately to Mars without the experience of learning to live and work on the lunar surface a few days away seems, to me, to be foolish.

With regard to the science, the Moon is an excellent laboratory for life science research and the effects of fractional gravity and deep space radiation environment on humans, at least in some respects. The radiation environment at Mars will necessarily be different from the radiation environment on the Moon, and that,

again, will be different from the radiation environment on the Space Station.

The Moon itself is a record of the sun's behavior for the last four billion years. It is—it may well be the only place in the solar system where we can capture that record, which is embedded in the lunar regolith. The lunar poles form a micro-environment on the lunar surface that may serve as cold traps for billions of years of cometary impact, so that we can understand the constituents of the primordial materials that formed—from which the Earth and the other planets were formed.

The Moon is an excellent place from which to conduct radio telescopy and optical astronomy. The Moon is a very and extraordinarily interesting place in and of itself. We will want to explore it.

The extent to which we want to trade money spent on the Moon from money spent going to Mars is a matter for future Administrators, future Congresses, future Presidents. What we are trying to do today is to put into place the capability to have those decisions in front of us. Today, we have no decision that is possible. We do not have the systems that would allow us to explore either Mars or the Moon or anywhere else.

Mr. MILLER. So at some point in the five to 10 years, this Congress is going to have to decide whether to invest in the research that would be necessary to take advantage of the opportunities that have—that putting humans on the Moon again will present to us?

Dr. GRIFFIN. I believe that is right. In about six years, we will have delivered the CEV. We will have the Station assembled. We will, at that point, be able to construct a heavy-lift vehicle, again, a Shuttle-derived vehicle, which will take us to the Moon and which will take us to Mars. And then it will be up to the Congresses, the Administrations, and the Administrators of that time to decide, in detail, what to do with that capability. We have put an architecture on the table by which any or all of those things can be accomplished, depending on the funding one wishes to assign and the priority one wishes to assign to the task.

Mr. MILLER. A somewhat related question. I appreciate the savings that come from using, to the extent possible, existing technology, off-the-shelf technology or updating the technology of the previous generation. I still like to think of it as just the last generation since I was in the ninth grade when we landed on the Moon. And I would like to think that two generations have not expired since I was in the ninth grade. But the cost of that, and one of the great advantages of the first effort to put human beings on the Moon, was the other uses of the technology that we developed and what we did to stimulate research generally, particularly out of research universities. Are we not cheating those other reasons, those other advantages, from space exploration by our complete focus on the economies of using the existing technology? Do you consider whether there is a balance to be struck by trying to develop—purchase technologies or develop new technologies that may have the collateral benefits of research that can be used in other ways or stimulation of research universities? Is that part of your thinking at all?

Dr. GRIFFIN. I would like for that to be part of our thinking, but the realities are—the fiscal realities are, first of all, that the creation of the transportation architecture to take people beyond low-Earth orbit, or even to replace the Shuttle's capabilities, are a high barrier to entry. Most nations of the world cannot afford to get over those barriers to entry. The United States can, but barely so. We are not, as a Nation, able to allocate the priorities of space exploration that we did in the generation of which you speak.

To put numbers on it, and to get away from pure dollar estimates, which change with time, it is commonly acknowledged today that at least 400,000 people were engaged in civil space exploration during the Apollo years. Today, all of NASA's budget, not just the space exploration budget, purchases the services of only 75,000 people. So we are spending less than a fifth for all of civil space exploration, less than a fifth of what we spent during the Apollo years in terms of the number of people's engagement that we can have.

That said, if we wish to make other choices, that is always possible at the Congressional and Administration level. But with the budgets we can bring to bear today, we must concentrate on very narrowly defined, very carefully defined, very specific goals that produce for the United States the enabling capability we need to get beyond low-Earth orbit, because that, again, is a very large barrier to entry.

Chairman BOEHLERT. The gentleman's time has expired.

CEV FUNDING AND EXPLORATION "SYNERGIES"

I just want you to know that sometimes we deliver what we promise. I said before we were so rudely interrupted by the need to go to the Floor to vote on a couple of—a dispute over a procedural matter, that we would try to bring some order over there. And we have. We are in recess now. So now we are back here.

Let me try to bring some clarity to an earlier question, because I am still sort of fuzzy about the specifics of your response.

If the vision is "go-as-you-pay," are we going on with a CEV acceleration when the NASA budget, as a whole, does not yet have the funds to carry out that acceleration?

Dr. GRIFFIN. We believe that there are substantial synergies to be extracted between the exploration program, as we have defined it that fits within its funding line, and the Shuttle program, as it—as we have inherited it, which, as you have observed, does not quite fit within its funding line.

But because the exploration architecture necessarily is derived, as Mr. Miller was just observing, from many of the Shuttle building blocks that we have available today, tanks and engines and things like that, we believe that there are substantial synergies to be extracted between the two programs.

Now we need to prove that to you. I understand that. We have had our architecture in place for not two months. We conducted a very intensive study over the summer, focused on meeting the goals of the vision in the most economical and time-efficient way that we could. We have not yet had time to blend that architecture with the existing Shuttle and Station program and try to obtain all of the efficiencies from those two things viewed as a combined program. We believe that we can do that. We believe that we can de-

liver the CEV to you with presidentially—the presidential budget request. We believe that we can deliver the CEV in 2012. If we can't, then, as we have said, it is a "go-as-you-can-afford-to-pay," and we will slip things in time, and yes, that will mean that we have sacrificed some efficiency.

Chairman BOEHLERT. And synergy is $5 billion?

Dr. GRIFFIN. As I said earlier, I don't believe that the total gap, at this point, is as much as $5 billion. I really believe it is somewhat lower, on the order of a few billion.

Chairman BOEHLERT. But that is significant.

Dr. GRIFFIN. It is very significant. If I try to be more precise than that right now, I would be making it up, and I don't want to do that. I need——

Chairman BOEHLERT. Well, we don't want to make up as you go.

Dr. GRIFFIN. Right. I know. And we need the next six months to be able to figure out how to blend the new exploration architecture with the Shuttle program that is being phased out to see how we can get our budget under control.

Chairman BOEHLERT. Well, experience, at least from the Chair's vantage point, has been that when you have said that you need x amount of time, in this case, you say six months, to bring some clarity to it, you usually fulfill your promise to bring some clarity to us. So we will take that.

Dr. GRIFFIN. I thank you.

I did—when I came in, I said in September I will have an exploration architecture for you, and I have. And I know what—people have criticized the architecture for being boring because it uses so many old and preexisting components, but no one has said it is inefficient. We have tried to do that. We said that we would define a Shuttle and Station architecture for you that fits within the number of flights we can expect the Shuttle fleet to have before it is retired. We have done that.

Chairman BOEHLERT. Is your sense—let us switch over a little bit.

FUNDING FOR THE JAMES WEBB SPACE TELESCOPE

Is it your sense that the Webb, now that the schedule has been pushed back, can stay on budget? And what gives you that confidence?

Dr. GRIFFIN. Well, it is my sense, first of all, that the Webb Telescope project is not overrun; it was underbid. I have tried very hard. The reason why I keep emphasizing that we have applied appropriate cost reserves to the exploration architecture costing is because our industry, and our agency, has a history of underbidding. And I am widely known not to support that nor want to do it.

We have had two independent assessments done of the Webb—of the James Webb Space Telescope, and both have concluded that the program itself is actually doing rather well, but the funding allocated to it initially was under-scoped by about $1.5 billion. We are remedying that in the out-years budgets. We are slipping the telescope slightly to allow—to require technology developments to take place. We think we will get it on target. I have got two completely independent cost estimates on the matter. They agree with

each other, and they agree as to the symptoms that led to the problem, so we are going to fix those.

KATRINA SUPPLEMENTAL

Chairman BOEHLERT. Let me ask you this. The White House has asked for $325 million for NASA to help pay for the Katrina-related costs at Stennis and Michoud. That is not nearly enough. That is about half of what you really need. Where is the additional money going to come from?

Dr. GRIFFIN. We—as you know in our last operating plan, we had requested $760 million, which was our best assessment of the damage that we had. Then——

Chairman BOEHLERT. And that was pared down considerably from the initial——

Dr. GRIFFIN. Well, the initial estimate was—we were still—I think we were still cleaning up——

Chairman BOEHLERT. Okay.

Dr. GRIFFIN.—some of the stuff, and it was——

Chairman BOEHLERT. So the $760 million is the estimate?

Dr. GRIFFIN. Yeah. The directions I gave to my folks were do not exaggerate the estimate. Every single thing that we put in the supplemental request must be accounted for. When we got done with that, that added up to $760 million, as we had indicated to the Committee.

Chairman BOEHLERT. And the supplemental contains the—calls for $325 million.

Dr. GRIFFIN. And that had a reserve on it of 20 percent for just us not knowing enough about what we were doing at the time of that supplemental. So the supplemental that you saw had that 20 percent reserve removed. It also had removed consequential damages, as we would say them in the MBA world, consequential damages associated with delays to the Shuttle program and things like that. So when those things were removed, you end up with the request that you got.

Now bear in mind the Administration does—is reserving the right to come in with another supplemental at a later time when things are more fully understood. So I don't believe that this is a dead issue. We think, for the moment, you know, we are fine with the $325 million.

Chairman BOEHLERT. So you fully anticipate a second supplemental so you won't have the need to raid other programs? You will have——

Dr. GRIFFIN. Exactly.

Chairman BOEHLERT.—the ability to pay the Russians, for example, for Soyuz? And there are a lot of other things you have to pay for.

Dr. GRIFFIN. We have more Katrina damage, and again, the Administration may very well bring another supplemental to the table.

Chairman BOEHLERT. And I am sure you would encourage the Administration to do so, at least with respect to NASA's needs.

Dr. GRIFFIN. I will have my best begging face on. Yes.

Chairman BOEHLERT. Thank you.

Who is next? Mr. Green.

Mr. GREEN. Thank you, Mr. Chairman. And I thank the Ranking Member. And I thank Dr. Griffin.

THE COTS PROGRAM

Doctor, it was great to be with you. Just recently, Mr. Chairman, I had the great opportunity to go to the Johnson Space Center and to receive a tour and to have the benefit of Dr. Griffin's insight while I was there. I also had the opportunity to actually go within the full-scale model of the Shuttle and to understand that it really is a no-frills operation and apparently the little space for the number of people who have to use the instrumentality.

I am interested in the $500 million that we will be spending for commercial space travel over the next four or five years. My first question has to do with the many persons who are currently working with this endeavor. As we make the transition to bring on board private enterprise, how will that impact the persons who are currently working in various positions?

Dr. GRIFFIN. The folks who are currently working on the Shuttle, of course, will be, in some cases, moved over to the CEV and, in other cases, we will not be able to use their skills on the new systems. And in yet other cases, they will go on to do other things. But the overall NASA budget, in constant dollars through the years in question, remains about the same. So the total NASA and contractor employment remains about the same. I mean, there will be winners and losers, but at a national level, the total picture remains about the same.

For that portion of our budget, which is being used, frankly, in an effort to stimulate the entrepreneurial community, we are hope that that will have leverage far beyond its amount, and it will actually increase the employment in aerospace by being able to attract the investors and the backers of these private entrepreneurial commercial enterprises to be able to participate with us in developing capability to ferry cargo and then later crew into space. If that occurs, then there will be a net savings for us, because we will be able, we hope, to purchase services now being provided by the government at a lower price by commercial industry. We will then be able to take those resources and utilize them for the frontier role of exploration, which we think is really NASA's proper role.

Mr. GREEN. My concern emanates from the notion that we have downsized, and I don't like really using the term, but from 400,000 to about 75,000, as you indicated, and I am concerned that this downsizing will continue and trust that it won't have an adverse impact on the scientists, the engineers, and the janitors, the persons who are working currently in these programs.

But moving right along to my next concern, the process by which we will make this transition, the selection of companies, can you speak to this, please, in terms of how you propose that we do this, such that we can get the entrepreneurs in place on time?

Dr. GRIFFIN. Well, sir, we are going to—shortly within the next couple of months, we are going to be putting a solicitation on the street, as we say. We will invite competitions. We will conduct a relatively standard source selection, evaluating the promised offerings, and we will pick from among the best. I don't have any spe-

cial wisdom or knowledge to bring to that task. It is something we do fairly frequently.

Mr. GREEN. We do it frequently, but have we done it for an endeavor of this magnitude before, because, literally, we are transferring something that we have held within our hands to private enterprise?

Dr. GRIFFIN. This is a bit new for us, and so we are not putting all of our eggs in one basket. We are actually developing a new basket, and I will be paying close, personal attention to this one.

Mr. GREEN. Well, I thank you for, again, the service that you render. It was an honor to have the opportunity to visit with you. And I am sure that we will talk more about these things as we progress.

Dr. GRIFFIN. My only concern is when you were in the Space Shuttle simulator flying with Mr. Calvert and, you know——

Mr. GREEN. He was outstanding.

Dr. GRIFFIN.—who knew how that was going to come out.

Mr. GREEN. We had a safe landing.

Thank you, Mr. Chairman.

I yield back.

Chairman BOEHLERT. Thank you very much.

Mr. Costa.

Mr. COSTA. Thank you very much.

SCIENTIFIC JUSTIFICATION FOR A LUNAR MISSION

Mr. Chairman, I do want to commend you and the Ranking Member for holding this hearing today. I think it is extremely important and fitting and appropriate that we, together, determine how the future of America's efforts for space exploration will be able to be continued over the next several decades, and so the debate, the discussion, and the priorities that we establish are critical to that future.

Mr. Griffin, I, too, want to give you high marks. As everyone has indicated, you seem to have taken this to—this new position like a duck to water, of sorts, and everyone believes that you have returned a level of credibility and capability that is essential to NASA's long-term success.

I have two questions that I want to ask you, and since we are in the parlance here that—today of golf, the first one is somewhat of a gimmie, the second one may be a little more of a difficult approach shot that may require good chipping skills.

The first question, really, is based upon—and I am trying to combine things that have been discussed here this morning as it relates to NASA's future, which is the science and the finances in terms of how we pursue the science.

The justification of—for—with the CEV project to go back to the Moon. Obviously, we have been there. We have accomplished that goal. But what sort of credibility are we all going to be able to talk about that is going to maintain the support through what will undoubtedly have to be successive Administrations that may vary in terms of political partisanship in nature? I mean, this is a long-term project, as you have described it today, and therefore, I think the credibility of the science on why we should go back is going to have to be essential, and we are going to have to be able to sub-

stantiate it in order to maintain the successive funding necessary to reach the goal.

Dr. GRIFFIN. That is correct, sir, and I would be happy to provide, for the record, a brief point paper on what we think some of the scientific returns are from returning to the Moon—for returning to the Moon.

But beyond that, the point that I have tried to make in many venues, and I will try again in this one, is that we are already, today, spending a significant amount of money on human space flight, human space exploration. It has, for the past 30 years, been limited to—more than 30 years, been limited to work in low-Earth orbit. Many of us believe, I believe, the folks who put together the *Columbia* Accident Investigation Board Report believed, and this Administration believes that restricting the United States to operations in low-Earth orbit, at this time, and for our future, is inadvisable. So while, obviously, more resources to do that job are always better than fewer, we are not, at this time, talking about the addition of large, new resources to the space program. Rather, we are talking about redirecting the money, which, today, is being spent on human space flight, into what we believe is a higher, better, more important, more strategically-significant, long-term goal for the United States. We have been, and we will be, spending money on human space flight. We want to spend it on different things that we believe are more strategically-relevant. That is fundamentally what we are talking about with the *Vision for Space Exploration.* It does require—in the short-term, the next few years, it requires some hard choices, some prioritization of goals. It requires things I don't like to do, like canceling advanced technology and not doing some science that we would like to do, because we are trying to phase out an older program and phase in a new one in such a way that we don't have jarring disconnects.

So it is a tough problem, but that is the goal.

Mr. COSTA. And I think you have explained that quite clearly.

LEVERAGING FUNDING BY INTERNATIONAL COOPERATION

As it relates to the finances, and Congressman Rohrabacher inferred and talked a little bit about it as he related to our partnership with the Russians, and we have discussed it today as it relates to our partnerships with others in the International Space Station, if, in fact, going to the Moon provides a sort of important science to all of mankind that will have far-reaching benefits, and if, in fact, which is, I think, true, and if, in fact, other countries are currently looking at trying to reach that goal, should we not be thinking about how we can combine resources with China, with Russia to share the costs? And notwithstanding the problems that have manifested themselves in our partnerships with the International Space Station. I would think that we could learn from those in terms of how we view the long-term in combining finances and thinking out of the box to make those finances as effectively-spent as possible.

Dr. GRIFFIN. I couldn't agree more, and on Tuesday, I gave a major speech on exactly that topic, and would be—I believe we have provided record copies to some of your staff, and I would be happy to do that. I am—have, on many occasions, said that I be-

lieve that the very best thing for our long-term future in space to come out of the Space Station partnership is the partnership. It has had strains, and the amazing thing is it has endured those strains and remains solid today. I—that should be continued and should extend to the future.

Mr. COSTA. Mr. Chairman, I know I am out of time, but if you—I beg the Chairman, I think this is an area that we need to continue to pursue and explore, given the nature of the challenges we face. And I would be very interested in reading your paper as it looks to prospective opportunities vis-á-vis thinking out of the box in terms of how we could share financial responsibilities as we go to the Moon.

Chairman BOEHLERT. Thank you very much, Mr. Costa.

And you are a major player, so any speech you give is major, I would think, in terms of significance, but——

Dr. GRIFFIN. Would you talk to my wife about that? She doesn't share your view.

Chairman BOEHLERT. I would welcome the submission if the staff could provide a copy of that speech, because——

Dr. GRIFFIN. We can.

Chairman BOEHLERT. And incidentally, when you give some of these major speeches, the staff might be well-advised to share some of your pearls of wisdom with us, because we are always learning. And they—oh, they do. Then my staff would be well-advised to share some of your pearls of wisdom that you share with them with me.

Dr. GRIFFIN. We did provide the speech to staff. We really did.

Chairman BOEHLERT. Thank you very much.

And now that we are mentioning pearls of wisdom, the Chair recognizes the gentlelady from Texas, Ms. Jackson Lee.

Ms. JACKSON LEE. What an inviting presentation, Mr. Chairman, and both in terms of the very erudite questions that the Chairman has—the Administrator has been willing to take from my colleagues. And thank you for yielding to me.

NASA'S WORKFORCE

Let me try to focus narrowly on points that have concerned me. And might I thank you for such an instructive visit to the Johnson Space Center just a week or so ago, and I invite my colleagues to visit all of the Centers, but certainly come on down to the Johnson Space Center where so much activity is occurring.

Might I also commend the NASA staff and cite what breath of fresh air the recent crew continues to provide, and particularly Commander Collins, who I know has a certain Congressperson as her Member of Congress.

But I would like to focus on some of the testimony we heard last week by the CFO and a number of presenters, including the Inspector General and those individuals. I am concerned that it is represented that 80 percent of NASA is contracted. And I say that with a great appreciation for the public-private collaboration that generates from many of our aviation research companies, and we know their names. And so when I begin this interest, I can imagine the frowning looks, with respect to why change what is perceived not to be broken. But I am concerned it makes it a very difficult

maze of accounting, which may be one of the issues that you will be confronting, but also, there is something to value to have systems engineers, to have the next, if you will, group of scientists, engineers, and others be looking to the government as a source to put their knowledge, at least the initial level of their knowledge.

I am told that China is graduating 600,000 engineers, and we are graduating 70,000. You may make that as a point, but that is the very reason why we need to be the recipient or the encourager of that kind of talent.

I understand that you may be, over the next couple of months, terminating 1,800 to 2,000 permanent employees. Why, if that is the case? And I will speak before hearing, and that is obviously always wrong to do, but I will do so and say that I oppose that. I don't understand it. And I think we are going in the wrong direction.

The other question would be on the issue of minority contractors. I still don't believe there is enough. There is always the question of ethical tampering—or unethical tampering, and then that always leaves us without anything to say. The percentages are not high enough. I would like them to be high enough. I would like to be a minority-only based conference to show minority companies around the country how do you effectively interact with the new contractual structure that NASA has. We have not had it. And when I say minority, minority and women. I think that is imperative.

And my last two points is your thought about a small grant to outreach to women and minorities as it relates to sciences that generated the likes of a Mae Jemison and Colonel Bolden and others. And with that, I would ask if you would share in your answers to me.

Dr. GRIFFIN. With regard to workforce, when I arrived in April, we had, the term that we will use is uncovered capacity, meaning civil servants who did not have specific jobs to which they could be assigned by virtue of the funding for—available from programs, you know, at their locations. We had an uncovered capacity of over 2,000 civil servants. This is a problem that had been inherited from many years of, frankly, not actively managing the match of our workforce skills to the job requirements. We are, as I said earlier, paying close attention to that in aeronautics. We are returning our aeronautics program to a program of fundamental aeronautical sciences research, which will help the issue.

On the new work that we are doing, the CEV, the crew launch vehicle, we are assigning, as much as possible, work from Centers that have surpluses of work to Centers which have less work. Through those strategies, we have reduced the uncovered capacity in the last four months, since we have been working the problem, down to about 950. We are—we have done—we announced one final buyout the—to be conducted, ending in January of 2006. We believe that will remove several hundred people from civil service roles.

We are doing everything we can within the constraints of the type of work that we are doing today to match that with the types of skills we have and minimize any untoward actions.

By next June, any uncovered civil servants that we still have in place will have to be rift. That will be our very last alternative. I also, Ms. Jackson Lee, deplore such an action. I have encountered that twice in my own career, in various circumstances. It is not fun, but we will do what we need to do in order to be fiscally sound by next June.

Ms. JACKSON LEE. That will leave you with how many civil servants working for NASA?

Dr. GRIFFIN. Well, it depends, again, on how closely we are able—we think we can get any rift down to a few hundred people, but at the end of the day, if none of our other actions works, that might be left, and that would leave us with approximately 18,000 civil servants at NASA.

Ms. JACKSON LEE. And about 2,000 would be in the group that either was placed somewhere or——

Dr. GRIFFIN. Most of the 2,000 will have been appropriately placed.

Ms. JACKSON LEE. And then a couple of hundred, possibly, if there are still remaining with uncovered job descriptions or no jobs available, would be rift around June of 2006?

Dr. GRIFFIN. That is correct.

Chairman BOEHLERT. I just want to make sure we clarify this for the record, but the rift might be announced in June, but it wouldn't be effective until the next fiscal year, beginning in October?

Dr. GRIFFIN. In October. That is correct.

Chairman BOEHLERT. Okay. All right. Fine.

Ms. JACKSON LEE. So there would be a couple of months of transition. Could you speak to the issue, because I think this is something I want to pursue with you in office and I won't—because of the time, would you just answer the minority contractors issue and the focused effort in the present configuration? And I know you are getting ready to say we do this all of the time, but hear me out. There are too many people that I interact with that suggest we don't do it all of the time. There is just this confused maze on how to interact under this new structure.

Chairman BOEHLERT. Well, let us hear a word from the Administrator on what they do do.

The gentlelady's time is expired, but this is a good question, and Mr. Administrator, we are anxious to hear from you.

Dr. GRIFFIN. I am going to have to respond for the record, because I am not sure exactly what you are asking. I attended, just within the last few weeks, a minority business conference where we were making awards to our important minority contractors. The impression I have come away with is that we are doing fairly well in meeting our minority and women-owned contractor goals. If you say we are not, I will take that under advisement. I will look at it, and I will get back to you, for the record, on how we are doing with those statistics. I had thought we were doing rather well.

Chairman BOEHLERT. And that would be helpful to all of us.

Dr. GRIFFIN. Yes.

Chairman BOEHLERT. Thank you very much.

Ms. JACKSON LEE. Mr. Chairman, if I can just finish one sentence, which is thank you very much. I do disagree, and I was talking more about outreach, because there is a pool of wide breadth

that don't have the inside information on how to plug in, and I would like to work with you on that.

And I yield back.

Chairman BOEHLERT. Thank you so much.

There is no time to yield back. We were very generous in extending the time——

Ms. JACKSON LEE. Thank you, Mr. Chairman.

Chairman BOEHLERT.—but we appreciate your input.

The gentleman from Tennessee, Mr. Gordon.

Mr. GORDON. Well, let me just conclude by saying thank you, Dr. Griffin, for being here. Your predecessor, and others from NASA in the past, have taken Muhammed Ali's "Rope-A-Dope" to another level. You have not done that. You tried to be concise, and it makes our job better, and I thank you for that.

Dr. GRIFFIN. Thank you, sir.

AERONAUTICS

Chairman BOEHLERT. Well, one final question, and this involves aeronautics.

We are pleased you are working to revive that area. That is very important, as I think on—to all of us up here. And what are we going to do to make sure that the fundamental research NASA is planning to conduct addresses a legitimate, unmet need and is marketable in the outside world?

Dr. GRIFFIN. Our new Associate Administrator has already conducted a couple of very significant workshops with regard to exactly that question. And we are working, as well, with OSTP and with FAA and DOD in the opening stages of crafting a—for a long—knew for a very long time, since we have had one, strategic plan for aeronautics. We, at NASA, do not see ourselves being the only stakeholders in aeronautics in this country, and seek, very definitely, to find a partnership of people who can help us say what it is that needs to be done and what is no longer required. So we will not be do—acting unilaterally in that regard.

That said, okay, we believe—I believe that aeronautical science in this country, the fundamental types of research that NASA, and NACA before NASA, used to be known for, has been missing for a while. I think we saw a recent example of that on the STS–114 flight with Discovery where we had—you will recall we had the gap fillers that didn't come out from between the tiles. There was some great concern about whether those might interrupt the flow of air on the undersurface coming in. We were not able to answer definitively whether that would occur or not, because the particular flight regime, very high number, very high altitude, rarefied flow, very high temperature gas dynamics involving, as it does, the transition from laminar to turbulent flow, is an area of state-of-the-art research in the aeronautics community, and we, NASA, have not been funding that. We should fund it.

Those are the kinds of fundamental sciences that we need to be doing, and I am convinced they will always be relevant.

TRANSFER AUTHORITY FOR THE KATRINA SUPPLEMENTAL

And if I could, before I end, make one final point.

On your Katrina supplement question, you know, you asked about the money, but with the money, also, went a request, on our part, to have the kind of transfer authority we need in order to be able to move money from where it is to where it needs to be to deal with the issues of recovering from Katrina. I would be——

Chairman BOEHLERT. Were you given that authority?

Dr. GRIFFIN. We are asking for it. I don't believe we have it from—don't have it yet.

Chairman BOEHLERT. Well, in closing, just let me make a couple of observations.

First of all, I hear words of praise for the new team you are assembling, the cavalry of people you have been able to attract to this very important agency for all of the important missions you have.

And also, with some degree of pride, Mr. Gordon and I read the recent survey that sort of estimated what all of the employees of all of the agencies of the Federal Government think about their role, their job satisfaction, the purpose of their mission, et cetera, et cetera, and NASA was number one in this great big government complex. I point out, with some degree of pride, that number two was the National Science Foundation. And I point out that that is under the jurisdiction of this committee, also.

So you have a most challenging assignment during a most challenging time, and we want to work with you. And we appreciate your approach to the job. We appreciate your availability, your candor, your willingness to consult, and your all-around general performance.

Thank you very much, Mr. Administrator.

Dr. GRIFFIN. Thank you, Mr. Chairman, Mr. Gordon. I very much appreciate the opportunity to talk to you today.

Chairman BOEHLERT. The hearing is adjourned.

[Whereupon, at 12:55 p.m., the Committee was adjourned.]

Appendix:

Answers to Post-Hearing Questions

ANSWERS TO POST-HEARING QUESTIONS

Responses by Michael D. Griffin, Administrator, National Aeronautics and Space Administration (NASA)

Questions submitted by Representative Bart Gordon

Q1. In your written testimony, you say "As we move forward, NASA will continue working closely with our International Partners to determine how they may best contribute to the Vision for Space Exploration."

Q1a. What does that mean in specific terms? How do you intend to make that determination?

A1a. Consistent with the initial steps in the *Vision for Space Exploration* (VSE), NASA is working closely with its international partners to meet its commitments on the International Space Station (ISS) program. In addition, in close coordination with the partners, NASA is working to refocus its ISS research efforts to support U.S. space exploration goals. NASA is also continuing to implement its existing international research missions such as Cassini/Huygens, Mars Global Surveyor, Mars Express Orbiter, Venus Express, James Webb Space Telescope and Mars Science Laboratory. We intend to maintain these strong international partnerships that have been built throughout NASA's history and extend them to sustain a robust robotic and human space exploration program. Since the VSE was announced, NASA has engaged other nations on a bilateral and multilateral basis to discuss potential partnerships to advance other objectives of the Vision. For example, NASA is currently in the process of negotiating agreements with the Indian Space Research Organization to host two NASA instruments on its first lunar mission, Chandrayaan; the Russian Federal Space Agency, to provide a neutron detector on NASA's Lunar Reconnaissance Orbiter; and conducting discussions with the Italian Space Agency, and Japan Aerospace Exploration Agency, who are developing their own lunar missions, on possibilities for scientific data exchange. NASA also conducted a series of workshops in 2005 aimed at understanding international plans for space exploration. In 2006, NASA is planning a second series of workshops, starting in the spring, to advance our understanding of potential international relationships in preparing humans and robots to explore the Moon and Mars. We intend to do this in a non-prescriptive manner. In addition, John Logsdon, director of the Space Policy Institute at George Washington University in Washington, DC, has been tasked by NASA to gauge areas of potential international collaboration in line with the Vision for Space Exploration. While the U.S. will provide the human-rated and heavy lift transportation systems to enable us to travel from the surface of the Earth to the Moon, develop lunar capabilities, and then go on to Mars and other destinations, we are exploring with international space agencies the best opportunities for international partnerships and relationships to occur, including as:

- Habitats, rovers, power and logistics;
- Science and in-situ resource utilization equipment;
- Data sharing;
- Lunar robotic pre-cursor missions; and
- Enhanced ISS re-supply.

Q1b. Does NASA have enough money set aside in its exploration plan to develop the lunar infrastructure it will need to make its lunar activities meaningful—or does NASA require international cost-sharing to make it work?

A1b. International cooperation is an integral element of the *Vision for Space Exploration.* Although NASA could, in theory, achieve the major milestones of the vision without international cooperation, we must maintain the strong international partnerships that have been built during the Space Station era, and must extend those partnerships even more broadly, to enable a robust human space exploration program. The development of crucial infrastructure such as lunar habitats, power stations, scientific laboratories and facilities, radio and optical telescopes, human-rated and robotic surface rovers, unmanned logistics and resupply vehicles, communication and navigation systems, in situ resource utilization equipment, and long-duration life support systems may, in part, result from a great exploration partnership between nations. We will need the aid of the international community as we encourage space exploration that will ultimately benefit all humankind; however, given the cooperative nature of international participation in the Vision, it is difficult to quantify the level of investment of existing and potential partners in the VSE.

Q1c. Your statement appears to be based on the unstated assumption that the International Partners are going to sign up to an American Vision for Space Exploration that they had no role in developing. How confident are you that they want to participate on those terms?

A1c. We are not prescribing the form such international contributions must take. NASA is not laying out a NASA-approved master plan for the infrastructure required for lunar exploration, which would then be prescribed for any partners. NASA seeks to work with the space agencies of interested nations to find ways to reach common objectives. We know from decades of international cooperation in space activities—most prominently on the International Space Station—that this approach to lunar exploration can work. We recognize that the international partnership formed to develop the ISS has been one of the program's best and most enduring features. We are confident that some of the most creative approaches to 21st century lunar, and subsequently Mars, exploration will arise out of similar future international collaborations. During recent visits between the NASA Deputy Administrator Shana Dale and NASA's International Partners, there was much interest in participating in the *Vision for Space Exploration.* We hope to promote common space exploration objectives and cooperative or complementary space exploration missions, along with the development of breakthrough technologies that will open up many opportunities for exploration and discovery. In the near-term, cooperative efforts in robotic precursor missions have already been formed. For example, NASA is currently in the process of negotiating agreements with the Indian Space Research Organization to host two NASA instruments on its first lunar mission, Chandrayaan; and the Russian Federal Space Agency, to provide a neutron detector on NASA's Lunar Reconnaissance Orbiter. NASA is also initiating discussions with the Italian Space Agency, and Japan Aerospace Exploration Agency, who are developing their own lunar missions, on possibilities for scientific data exchange.

Q2. What do you consider to be the most important *justification for the planned human lunar exploration program: Preparation for human missions to Mars? Scientific research on the Moon? National prestige? Or something else?*

A2. Each of the lunar exploration themes that was mentioned as a goal: preparation for Mars, scientific research on the Moon, and National science and technology capabilities, along with many others including: advancing technology; enabling international partnerships; and encouraging commercial development activities, is key to a comprehensive lunar exploration effort. In many cases, specific activities that may be planned for future robotic and human missions to the Moon might each support a number of these lunar exploration themes. The primary challenge is to determine an optimal way to integrate these themes into a comprehensive, efficient and highly effective strategy of lunar exploration. In 2006, NASA is leading an effort to pull together the various constituent groups from the science and space commercialization areas, along with representatives from the space agencies of many nations who have a strategic interest in exploring the Moon. The goal of this activity is to bring these communities together to discuss common and conflicting interests and to establish an integrated strategy for lunar exploration. Within this strategy, NASA will be pursuing a number of roles, including:

- Providing leadership in exploration of the Moon;
- Developing advanced technologies;
- Enabling lunar commerce, international participation, and science;
- Preparing for future human missions to Mars—these missions will not be safe without having first gained experience through our lunar exploration effort.

Q3. A "go as you can pay" approach to NASA's Exploration program seems to make sense. However, I am not sure how it would work in practice. In other words, once the contractor and civil service "standing army" is in place to support various Exploration-related development projects, stretching the exploration schedule due to budgetary shortfalls will likely result in increased project costs due to the need to keep the workforce on the payroll longer. The desire to avoid such cost increases would seem to lead to pressure to transfer funds from other parts of the NASA budget to avoid delaying the exploration projects.

- *Can you explain how you would avoid such a situation from developing?*
- *Several years ago, Tom Young's IMCE Task Force attributed a share of the International Space Station's cost growth to NASA managing that program to meet annual budgetary targets. Isn't managing the program on a "go as you can pay" basis essentially the same thing? How do you plan to avoid getting into the same situation that the IMCE warned against?*

A3. NASA's budget for Exploration uses a "go as you can afford to pay" approach that requires the Constellation program to accomplish the *Vision for Space Exploration* in a given budget profile. The work and workforce are planned such that we can efficiently utilize the resources in any given year as we are working toward accomplishing the Vision. Go as you can afford to pay does not equate to having *an arbitrarily chosen* level-of-effort workforce working without a plan. Rather it reflects a plan that joins an appropriate amount of specific content taking place any given year with the appropriate level of phased funding to accompany a set of defined mission activities. It only means that we will have to accomplish the work within a set budget. In effect, it means that the exact year we accomplish our objectives may move earlier or later, depending on whether we find efficiencies within our present plan or whether we encounter unanticipated difficulties.

Q4. When will NASA have a transition plan for the Shuttle workforce completed?

A4. As requested in the *NASA Authorization Act of 2005* (P.L. 109–155), NASA plans to deliver a Space Shuttle workforce transition plan to the Congress by March 31, 2006. We expect to deliver this plan by the end of March or early April.

Q5. NASA is part of the Joint Planning and Development Office (JPDO)—a joint initiative by NASA, FAA, DOD, and other federal agencies to develop the next generation air transportation system. The JPDO is depending on NASA's R&D to meet the goals of its integrated plan, which will require an increasing commitment of NASA resources over the next five years and beyond. However, NASA's aeronautics budget is projected to decline significantly over the next five years under the Administration's budget plan. How do you plan to meet NASA's commitment to the research needs of the JPDO under a declining NASA aeronautics budget?

A5. One of the three guiding principles of the reshaped Aeronautics Program is our commitment to align directly our Air Traffic Management research and development to address the fundamental research challenges inherent to the NGATS vision articulated by the Joint Planning & Development Office (JPDO).

The JPDO has identified the capability requirements needed for the NGATS, assigning key roles to the member agencies. NASA's research will help make NGATS possible by taking on some of the most technically challenging aspects of system transformation. The research spans critical technology for intelligent aircraft systems and advanced vehicle performance and forms the foundation for safety and capacity in the future. The unprecedented challenges faced in this transformation will require a focused and long-term commitment by NASA and its federal partners.

The JPDO has reviewed the early elements of the re-planned Airspace Systems Program and has provided comment on their relevance and priority within the overall vision of NGATS 2025. As the detailed technical and programmatic planning of the ASP project elements ensues over the next several months, NASA will maintain a continuing dialogue with the JPDO. This will ensure that the Airspace Systems research agenda continues to focus on the high-value challenges facing the JPDO vision for 2025 and, hence, the critical concerns of society and the aviation industry. The investment of the Airspace Systems Program resources will be made in the most efficient manner possible to enable the greatest impact for the transformation of the national airspace system.

Q6. Senior management at both Goddard Space Flight Center and the Jet Propulsion Laboratory have emphasized the need to maintain in-house at least one program of a reasonable scale and with significant technical challenges in order to provide the kinds of experiences needed to develop the employee skills needed to create the kind of managers you intend to rely on. Do you agree with that philosophy? If so, how will it be implemented?

A6. NASA's new Strategic Plan (p. 23) states that the SMC proposed a set of attributes that define strong, healthy Centers. These attributes included, inter alia, "Major in-house durable space flight responsibility" and "Technically competent and value centered leadership." To implement this strategy, agency business planning processes will reflect this strategic direction:

- Centers will be expected to build and maintain their internal capabilities through identification of such work that supports Mission Directorate programs and execution of that work that is assigned to them;
- Mission Directorates will be expected to assist the Centers in identifying and assuring that work within the Mission Directorates' portfolios that can provide this kind of needed experience to Center workforces is assigned to centers for this purpose; and

- the Agency will monitor the extent to which centers' workload contains appropriate work of this nature and take steps in the overall business planning process (e.g., strategic make/buy decision) to remedy any situation where issues develop with respect to sustaining this type of work at a particular Center.

The Administrator underscored this in his budget rollout yesterday that included the statement that NASA will assign new projects to field centers to strengthen their base of in-house work.

Questions submitted by Representative Mark Udall

Q1. What are the prioritized objectives of NASA's plans for human activities on the lunar surface? How were those objectives determined and prioritized?

A1. The objectives of the lunar exploration effort include preparation for Mars and other destinations, scientific research on the Moon, improving national science and technology capabilities, advancing technology, enabling international partnerships, and encouraging commercial development activities. In many cases, specific activities that may be planned for future robotic and human missions to the Moon might each support a number of these lunar exploration themes. The primary challenge is to determine an optimal way to integrate these themes into a comprehensive, efficient and highly effective strategy of lunar exploration.

In 2006, NASA is leading an effort to pull together the various constituent groups from the science and space commercialization areas, along with representatives from the space agencies of many nations who have a strategic interest in exploring the Moon. The goal of this activity is to bring these communities together to discuss common and conflicting interests and to establish an integrated strategy for lunar exploration. Within this strategy, NASA will be pursuing a number of roles, including:

- Providing leadership in exploration of the Moon;
- Developing advanced technologies;
- Enabling lunar commerce, international participation, and science;
- Preparing for future human missions to Mars—these missions will not be safe without having first gained experience through our lunar exploration effort.

Q2. What are the prioritized scientific objectives of NASA's human lunar exploration program? How were those objectives determined and prioritized? If such a set does not yet exist, when will it be available?

A2. NASA plans to establish an integrated set of long-range science goals for robotic and human lunar exploration. Important aspects of lunar science were addressed in the NRC's recent solar system exploration decadal survey, New Frontiers in the Solar System. At the present time, SMD is working with the NASA Advisory Council on a near-term plan to review and extend these and other identified science priorities that can be addressed on the Moon in the context of the broader science program. This process is expected to also involve the NRC Space Studies Board.

Q3. Does NASA plan to issue an updated strategic plan? If so, when?

A3. On February 6, 2006, NASA issued a new 2006 NASA Strategic Plan. The Strategic Plan is available online at: *http://www.nasa.gov/about/budget/index.html.* We do not plan to publish another strategic plan for three years.

Q4. In your June 28, 2005 appearance before the Science Committee, you indicated that the restructured research plan for the International Space Station program would be provided to the Congress "later this summer." *As of the November 3rd hearing, it still had not been transmitted to Congress. Please provide the restructured ISS research plan for the record.*

A4. A consolidated ISS Utilization plan is being prepared for the Congress per the Authorization Bill, and will be delivered to Congress on or before the 90-day requirement (March 30, 2006).

Q5. In your June 28, 2005 appearance before the Science Committee, you also indicated that the proposed final configuration and assembly sequence for the International Space Station program would be provided to Congress later this summer. As of the November 3rd hearing, it still had not been transmitted to Congress. To date, all Congress has seen is a one and a half page summary of the study's results. Please provide for the record the following items:

- *The Report of the Shuttle/Station Configuration Option Team study*
- *The proposed final configuration of the International Space Station and assembly sequence referenced in your proposed 18-flight ISS assembly plan*

A5. Enclosure 1 is a copy of the Report of the Shuttle/Station Configuration Option Team study and Enclosure 2 is a copy of the proposed final configuration of the International Space Station and assembly sequence referenced in an 18-flight ISS assembly plan that was being discussed in 2005. It is important to note that this proposed assembly sequence is not final. NASA is now working with the international partners to develop an ISS assembly plan that meets international commitments using the minimum number of Shuttle flights.

Shuttle/Station Configuration Options Team (S/SCOT) Study Synopsis

Enclosure 1

NASA Headquarters

January 2006

National Aeronautics and
Space Administration

Shuttle/Station Configuration Options Team (S/SCOT)

Study Synopsis

Overview

At the direction of the NASA Administrator, NASA convened the Shuttle/Station Configuration Options Team (S/SCOT) on May 16, 2005. The team, based at NASA Headquarters in Washington, DC, evaluated options for completing International Space Station assembly within the parameters of the Vision for Space Exploration, announced in January 2004. The team primarily focused on balancing the need for a robust, sustainable Station configuration with the Vision's requirement to retire the Shuttle no later than 2010.

NASA assembled a team of experts to conduct the study, including some external, subject-area authorities who participated in an advisory capacity. The team reported its findings to the Administrator in late June; a select sub-team continued work into July in order to integrate S/SCOT results with an Exploration Systems Architecture Study being conducted in parallel.

Study Approach and Methodology

The team examined six key attributes as part of the S/SCOT study. *ISS mission objectives* were considered as a function of *Agency mission needs* to achieve the exploration vision. The team began by identifying a limited set of *programmatic constraints*, to define criteria for systematic and objective evaluation of ISS *configuration options*. The evaluation phase then focused in on *option implications* so that decisions could be made based on full knowledge of the effects of cost, schedule and technical changes to the Shuttle/Station baseline. Each of the steps was performed by authoritative subject-area experts, thus enabling a fully informed *Administrator decision* and subsequent recommendation to the White House.

Agency Mission Needs and ISS Mission Objectives

NASA's new exploration agenda, defined by a human return to the Moon in the near term (10-15 years) and human expeditionary excursions to Mars in the long term (15–20 years), sets the stage for the Agency to re-evaluate its mission needs in the areas of science and technology. For study purposes, these needs were summarized as:

- Φ High availability spacecraft systems (i.e., systems of sufficient reliability with provisions for effective maintainability, such that on-line system availability is high);

- Φ Sustained performance of crew with specialized skills and cross-training (i.e., high proficiency crew with minimized susceptibility to the physiological and psychological rigors of extended missions), and;
- Φ In-space operational experience at crew-system interfaces.

ISS mission objectives were reconsidered from this perspective in order to identify contributions directly related to Agency mission needs. For study purposes, the new ISS mission objectives were summarized as:

- Φ Research, development, test and evaluation of selected systems for long-duration space missions;
- Φ Research, development, test and evaluation of biomedical protocols for human health and performance on long-duration space missions, and;
- Φ Development, demonstration and validation of operational practices and procedures for long-duration space missions.

Mission requirements were then derived for later use in evaluating the degree to which a particular ISS configuration option met the new ISS mission objectives.

Programmatic Constraints

Before developing configuration options, the team had to establish a limited set of programmatic constraints as boundary conditions on potential solutions. Only absolutely critical constraints were considered in order to maximize the option space. These constraints included:

- Φ Cease Shuttle Orbiter operations by the end of FY 2010;
- Φ Employ an achievable Shuttle flight rate;
- Φ Meet international partner commitments, and;
- Φ Complete the ISS in a sustainable configuration with acceptable vehicle and crew risk.

To quantify an achievable Shuttle flight rate, the team employed two probabilistic models. The Kennedy Space Center-developed "Manifest Assessment Simulation Tool" was used to establish a numerical range of missions NASA could fly before the Shuttle retirement date. Pessimistic, neutral and optimistic sets of input parameters were modeled to bound the range of outcomes for cases involving both serial and parallel Orbiter processing.[1] These results were verified through parallel modeling efforts undertaken by an outside contractor, Valdor Corporation, in order to ensure independent confirmation.

Configuration Options

[1] Serial processing is defined as a change to single-shift workforce operations that limits processing capability to one orbiter at a time. As a result, no more than two shuttles can be launched each year. Currently, parallel orbiter processing employs a three-shift workforce that can support four, or more, Shuttle flights per year.

Approximately a dozen options were identified in general conceptual terms, ranging from immediate de-commissioning of both the ISS and the Shuttle to concepts involving new system development. The trade space included aspects of both content and schedule. Station configurations were considered with, and without, build-out of the Station truss and its associated power/thermal blocks, and involved various combinations of international partner laboratories. The team considered assembly schedules that deferred major elements based on potential new alternative transportation systems, or truncated assembly at sustainable intermediate configurations.

By considering each alternative in terms of major Station elements, Shuttle flight requirements, and relationships between the options and programmatic constraints, the team narrowed the range of options to three scenarios. The options selected for a detailed cost, schedule and technical analysis included:

- Φ 11+1 Shuttle flights[2], with deferral of all further assembly and International Partner laboratories deployment until after 2014;
- Φ 17+1 Shuttle flights, with deployment of both the European and Japanese laboratories and a high risk to sustain, and;
- Φ 22+1 Shuttle flights, with deployment of both the European and Japanese laboratories, and a moderate risk to sustain.

All three options fell broadly within the programmatic constraints; however, the "11+1" option entailed additional schedule assumptions. Deferring launch of the European and Japanese laboratories to post-2014 would presume a new Shuttle-derived launch vehicle (SDLV) being developed and proven by the U.S. within eight years. This development would have to be conducted partially in parallel with development of the new crew exploration vehicle (CEV) and crew launch vehicle (CLV).

Option Implications

The bulk of the S/SCOT activity was focused on identifying, analyzing and characterizing in detail each option so that a fully informed objective executive decision could be made. The team considered the following types of implications:

- Φ Capability to achieve the new mission objectives;
- Φ Impacts on international relations;
- Φ Risks to engineering sustainability of the configuration, and;
- Φ Requirements for fiscal resources.

Capability to Achieve the New Mission Objectives

Mission requirements for user resources (crew-time, power/thermal, and up/down mass transportation) and for user accommodations (internal payload rack volume and external

[2] For each scenario, the "+1" denotes the possible addition of one flight for a Hubble Space Telescope – Servicing Mission 4 (HST-SM4) in FY 2008 over and above the number of Space Shuttle flights assigned to complete ISS assembly.

attachment sites) were defined consistent with the new mission objectives[3]. All three options met targeted on-board resource and accommodation requirements for U.S. exploration research and technology (R&T) development. The "11+1" option offered earlier R&T opportunities, since ISS assembly activity would be suspended for eight years. The "17+1" and "22+1" options offered opportunities for continued crew biomedical research during assembly, while growth in R&T scope remained reliant on availability of post-Shuttle cargo transportation vehicles.

Since the new mission objectives could be largely achieved in all scenarios, this factor was not decisive.

Impacts on International Relations

The European Columbus Orbital Facility (COF) and the Japanese Experiment Module (JEM) were of primary consideration due to the visibility of these significant government investments within their respective countries. Closely coupled with these laboratory modules were the European Automated Transfer Vehicle (ATV) and Japanese HII Transfer Vehicle (HTV) that are being developed principally to service Columbus and JEM. Services from use of these vehicles are also used to offset the European and Japanese shares of the Common Systems Operations Costs.

In addition to the national laboratory and transfer vehicle investments, the team considered a number of secondary investments by the international partners. These investments primarily consisted of elements developed by partner agencies for the U.S. (i.e., Nodes 2 & 3, Cupola, Centrifuge Accommodation Module) and designed to offset costs of U.S. launch of the partners' laboratory modules.

The remaining major element was the Russian Solar Power Module (SPM) that was to be delivered by the Shuttle as part of the U.S. contribution under the bilateral ISS implementing arrangement with Russia known as the Balance Agreement. In the absence of a Shuttle launch of the SPM, NASA would be required to compensate Roskosmos for the value of those Shuttle launch services in order to maintain the relative balance of contributions.

Because the European and Japanese laboratories would be delivered by the Shuttle in the "17+1" and "22+1" options, this factor weighed in favor of these options over the "11+1" option that deferred delivery to a new SDLV in the post-2014 timeframe. None of these three options accommodated launch of the Russian SPM.

Risks to Engineering Sustainability for the Configuration

The ability to sustain the Station is highly dependent on the physical and functional scope of its configuration. The S/SCOT devoted most of its attention to this critical

[3] The need for a 2.5 meter diameter centrifuge facility to accommodate specimens involved in fundamental biological research was re-assigned a low priority in the new R&T portfolio and the requirement was withdrawn.

implication. The team determined it would be unwise to complete the Station without the ability to sustain it. A decision to launch the partner laboratories carries with it a commitment to providing the infrastructure to sustain them. This scenario leads to a chain of necessary Shuttle flights that drive the assembly sequence. The S/SCOT characterized this chain of events in three stages.

In the first stage, the flight of the partner labs would increase power demand on the Station electric power system. The current on-orbit configuration produces approximately 20kW and meets current core systems power demand. Partner laboratories would increase this core system demand to almost 40kW and require building out the Station truss with the corresponding power/thermal blocks. The truss build-out would require four to five additional Shuttle flights, while the deployment of the laboratories would add a further four flights. This truss build out operation would be necessary to restore a positive energy balance with contingency provisions.

In the next stage, the challenge becomes sustaining power production through regular servicing of the power/thermal system orbital replacement units (ORUs). The amount of additional extravehicular activity work required to handle expected maintenance and repairs on the external ORUs would exceed the work that could be done by three crew members by about 250 hours. In order to perform the necessary amount of additional work, the crew size would need to be increased. However, a bigger crew requires additional life support, which in turn requires an additional two to three Shuttle flights.

Finally, the Station would need additional storage for on-orbit spares. The Station now has a limited capacity to store ORUs on-orbit. This requirement would grow to more than 4,000 kg per year with the build out of the truss and addition of the international partner laboratories. The delivery of external spares directly affects station lifetime. Since external ORU performance, in terms of mean time between failure and mean time to restore, is an analytical projection for which there is little operating experience, the quantity of spares delivered to orbit corresponds closely to the level of risk accepted. The S/SCOT determined a range of three to six additional Shuttle flights would be required depending on whether the Agency was prepared to accept a high to moderate risk on the ability to successfully sustain the configuration during the 2008-10 timeframe.[4]

A pivotal aspect of the sustainability analysis was the readiness date for the Japanese HTV because it has the ability to deliver external spares to the Station. The S/SCOT projected the HTV-1 demonstration flight to be no earlier than 2009. However, the team also noted that technical challenges with developing automated transfer vehicles are substantial and no demonstrations to date have achieved projected schedules.[5]

When Shuttle requirements for payload and crew logistics (two to two and a half Shuttle flight equivalents) were added to the Return to Flight test flights (two Shuttle flight

[4] A low risk posture was not considered because it would imply a shift back toward the original 28-flight baseline and violate the constraint on employing an achievable flight rate.

[5] The recent MSFC DART (Demonstration for Automated Rendezvous and Docking) mission anomalies and persistent slippage in the European ATV-1 demonstration were noted in these discussions.

equivalents), the sustainability analyses contributed to an overall Shuttle flight requirement in the range of 17-22 missions with added dependency on HTV readiness.

Requirements on Fiscal Resources

The S/SCOT-developed Shuttle/Station budget estimates for each of the three selected options for the period FY 2006–2016 and compared them to the FY 2006 President's Budget Request (PBR).[6] While there was some variance from the FY 2006 PBR, estimates offered little discrimination among the three options.

Administrator Decision

Comprehensive study findings were briefed to the Administrator in July 2005. An option was not recommended by the S/SCOT; instead, discussions focused on the risk of sustaining the ISS without Shuttle versus the number of Shuttle flights achievable by the close of FY 2010. Dependency on HTV readiness was a major consideration.

The S/SCOT completed a further analysis of the maximum delay in HTV-1 that could be endured before Station power generation fell below core system demand. This analysis indicated that if two additional Shuttle flights for truss spares were added to the "17+1" option, then a delay of up to approximately three years in HTV-1 would not pose a loss-of-Station threat.[7] A "19+1" option was thus identified as optimal because of the need to adjust risk from high toward moderate, balanced with reasonable expectations of the number of Shuttle flights that can be flown by 2010.

The Administrator elected to proceed with a "19+1" option. [This included STS-114, which has since flown] This option reflects a strategy to first complete the necessary power/thermal infrastructure, then deploy the International Partner laboratories, and last provide - logistics support to maintain the station with spares. Implementation of the strategy will concentrate on achieving the specific goals of the vision for space exploration rather than focusing on the exact number shuttle flights.

Currently, as articulated in the FY 2007 Budget Request for NASA, the Agency will continue with assembly of the ISS with the minimum number of Space Shuttle flights necessary to fulfill our commitments to our international partners before the Shuttle's retirement in 2010.

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[6] The estimated costs for an HST-SM4 mission plus remediation costs associated with phase-out of Shuttle ground-based assets were included in the estimates, but did not represent a discriminator because they were roughly equivalent in all options.

[7] The S/SCOT also agreed that it was very unlikely that any alternative transfer vehicle with non-pressurized cargo capacity for ISS spares could be developed and demonstrate automated rendezvous and docking capability before the end of 2010.

ISS Assembly Sequence

Flt	Delivered Elements/Milestones
ULF1.1	MPLM-P(OGS, 2 ISPRs, RSPs/RSRs); ICC (PM, TUS RA, 2 FGB); LMC(TPS DTO)
12A	P3/4
12A.1	P5; SHAB(Single); ICC(3 SMDPs)
13A	S3/S4 w/ PVR
13A.1	S5; SHAB (Single); ESP3 (NTA, BCDU)
ATV1	ATV1 First Flight
15A	S6 (P6 move)
10A	Node 2 (4 Sys racks, 2 ZSRs, 2 RSRs); Sidewall(PDGF)
1E	Columbus Module (3 Sys Racks, 4 RSPs, 5 ISPRs); MPESS--ND (2 EPF P/Ls)
ULF2	MPLM-P (WRS1, WRS2, WRS 1&2 Outfitting, ARED, ARED Outfitting, ISPRs, Resupply RSR/RSPs); LMC(NTA)
3R	Multi-purpose Laboratory Module (MLM) w/ ERA
1J/A	ELM PS (3 ISPRs, 4 JEM PM System, 1 JEM RSR); SLP-D1 (SPDM/"Dextre", SPDM EOTP) -- Rtn: SLP-D1
1J	JEM PM(4 JEM Sys racks, JEM RMS)
17A	MPLM-P (3 Crew Qtrs, 1 JEM ICS RACK, JAXA Outfitting, RSR/RSPs, ISPRs); LMC(ATA)
2J/A	JEM EF; ELM ES (EF P/L, ICS, SFA); SLP-D2 (6 Batteries) -- Rtn: SLP-D2
ULF3	ELC1 (MLM Outfitting, Pre-positioned Spares); ELC2 (Utilization, Pre-positioned Spares)
HTV1	HTV1 First Flight
19A	MPLM-P (Galley, WHC, TVIS2, TVIS2 Outfitting, CHeCS2, RSR/RSPs, ISPRs); LMC(ATA)
	Establish Six Person Crew
*ULF4	ELC3 (Utilization, Pre-positioned Spares); ELC4 (SM MMOD Wings, Utilization, 6 Batteries) -- Rtn ELC1 (NTA, EPF P/L)
20A	Node 3 w/ Cupola (2 Avionics Racks, ARS, 5 ZSRs)
*ULF5	ELC5 (Stbd MT/CETA Rails, Utilization, Preposition Spares); ELC1 (Utilization, Pre-Positioned Spares/Corrective Maintenance)
	ISS Assembly Complete
9R	Research Module

Two Shuttle-equivalent flights for contingency (not planned)

2/6/06

Enclosure 2

Q6. Many in the life sciences research community have expressed alarm over NASA's decision to terminate the ISS Centrifuge program in the face of decades of findings by the National Academy of Sciences that the absence of a Centrifuge could hinder NASA's ability to gain the fundamental knowledge essential to maintenance of astronaut health on long-duration space missions.

- *Why did you decide to terminate the Centrifuge program?*
- *How do you intend to answer the research questions that the Centrifuge was designed to address?*

A6. NASA has eliminated animal research on the centrifuge for the ISS after evaluating the relative costs and benefits of this program. In particular, the research has been canceled because of: 1) a higher priority for biomedical research with human subjects than for research with animals to meet the Nation's exploration goals; and 2) logistic priorities caused by the requirement to focus remaining Shuttle flights on finishing the International Space Station, and the inability to plan to send specimens and supplies to the ISS for use on the centrifuge between 2010 and 2016.

While the full research program centered around CAM and the questions it was intended to address will not be fully realized, there will be new, but reduced NASA research opportunities in biomedical science. The life sciences research portfolio content has shifted from lower Technology Readiness Levels (TRLs) to higher TRLs with more specific, directed outcomes than was required in the past. In addition, 15 percent of the funds budgeted for ISS research will be allocated to a potential combination of ground-based, free-flyer, and ISS life and microgravity science research that is more fundamental in nature and not directly tied to exploration goals.

Q7. NASA's new Associate Administrator for Aeronautics has announced that NASA will reorient its activities away from technology demonstrations and technology development programs to fundamental research. While it makes sense to restore a fundamental aeronautics research program at NASA, there is concern within the aviation community that NASA is at serious risk of eliminating R&D of relevance to the aviation industry and critical to addressing societal concerns related to aircraft noise, emissions, and congestion in the air transportation system.

- *How do you plan to ensure that NASA's R&D activities will be both relevant and of sufficient magnitude to have a positive impact?*

A7. The JPDO has reviewed the early elements of the re-planned Airspace Systems Program and has provided comment on their relevancy and some indication of their priority within the overall vision of NGATS 2025. As the detailed technical and programmatic planning of the ASP project elements ensues over the next several months, the results of the review by the JPDO will guide program content to ensure relevancy and impact to the JPDO vision for 2025 and hence address the critical concerns of society and the aviation industry.

In addition, NASA is taking a fresh look at the research required to ensure that future air vehicles will be environmentally compliant. We have solved some of the problems that we have already addressed. We have reduced NO_X emissions through a low NO_X combustor that produces 70 percent less emissions than a reference design. We have reduced engine noise to the point that almost half the noise produced by aircraft on approach to an airport is generated with the engines off. But the days of working problems in isolation are over. We cannot work emissions and noise without also addressing overall vehicle efficiency if we want to see environmental solutions make their way into the aircraft fleet. A holistic approach requires significant advancement in our design capabilities. This in turn requires substantial investment in cutting-edge research across the breadth of aeronautics disciplines. Only then will we be able to design the vehicles that meet these future challenges.

NASA is taking a long-term strategic approach to the enabling technologies that are critical to the future of aviation. We are developing system-level, multi-disciplinary tools to enable advanced civil and military aircraft. The key to addressing societal concerns such as noise and emissions is to take a systemic view of these issues. We must design the total aircraft for low noise rather than simply producing low-noise components (such as engines). These designs will take industry out of the comfort zone where they have years of prior experience, and the advanced design tools we develop will allow us to work these radical new designs. We will work fundamental scientific and engineering issues in noise and emissions generation such as noise source characterization, combustion chemistry, and active flow control which are needed to enable breakthroughs in noise and emissions reduction. We will work to better understand what emissions components are most hazardous, and we will develop new scientific standards for emission levels. Finally, we will address chal-

lenges in performance to ensure that our industries and our airlines remain competitive in the global marketplace.

The NASA aeronautics program has changed precisely because the problems we must solve in the 21st century are that much harder. We choose to invest in fundamental research because it is the only rational way forward.

Question submitted by Representative Eddie Bernice Johnson

Q1. What are NASA's current efforts in funding and support for science, technology, engineering, and math education and career development?

A1. Education is a fundamental element of NASA's activities reflecting a balanced and diverse portfolio of: Elementary and Secondary Education, Higher Education, e-Education, Informal Education, and Minority University Research and Education Programs.

Previous experience has shown that implementing exciting and compelling NASA missions are critical to inspiring the next generation of explorers, innovators, and leaders. Through partnerships with the Agency's Mission Directorates, other federal agencies, private industry, scientific research, and education/academic organizations, we are applying NASA's unique mission and education initiatives (content, people, and facilities) to spark student interest and to guide them toward careers in science, technology, engineering and mathematics (STEM).

To compete effectively for the minds, imaginations, and career ambitions of America's young people, NASA's Office of Education has created a diverse portfolio of education initiatives that focus on engaging and retaining students in STEM education programs to encourage their pursuit of educational disciplines critical to NASA's future engineering, scientific, and technical missions. In addition to the programs managed by the Office of Education outlined below, NASA invests additional resources in Mission Directorates and NASA Center operations to address education programs. The education portfolio includes the following:

Elementary and Secondary Education

Educator Astronaut Program selects outstanding educators to become permanent members of the Astronaut Corps. The program uses the visibility and educational opportunities created by the activities of the Educator Astronauts to inspire greater K–12 STEM achievement, promote STEM careers, and elevate public esteem for the teaching profession. The program has also trained the top tier of Educator Astronaut applicants, called the Network of Educator Astronaut Teachers, to perform as NASA Education advocates by engaging their schools and communities in NASA education activities and informing them of NASA resources (content, people, facilities).

Aerospace Education Services Program serves the elementary and secondary education community by providing classroom demonstrations, faculty workshops, parent training, in-service training for teachers, and identification of appropriate classroom resources. NASA uses former teachers who are well-trained and well-equipped in STEM content.

NASA Explorer Schools offers a three-year partnership between NASA and school teams, consisting of teachers and education administrators from diverse communities across the country. Focusing on under-served populations, the program is designed for education communities at the 4–9 grade levels to help middle schools improve teaching and learning in STEM education through significant structural (professional development, stipends, grants) and curricular support based on NASA resources.

Science Engineering Mathematics and Aerospace Academy Program reaches K–12 minority students that are traditionally under-represented in careers involving STEM. Students meet during school, after school or on Saturday mornings and during the summer to engage in hands-on, interactive learning sessions that are specifically designed for each grade level.

Education Flight Projects provides hands-on experiences to inspire and motivate students to pursue studies and careers in STEM through participation in NASA research applications. Programs are integrated into a seamless pipeline to encourage sustained student interaction with NASA that results in expanding the pool of human capital to meet the needs of NASA and its partners.

Higher Education

Space Grant, a national network of colleges and universities, works to expand opportunities for students and faculty to understand and participate in NASA's aeronautics and space programs by supporting and enhancing science, and engineering education, research, and public outreach programs.

Experimental Program to Stimulate Competitive Research develops academic research enterprises that are long-term, self-sustaining, and nationally competitive by supporting states with modest research infrastructure to become more competitive in attracting research funding. Over twenty states may be eligible to compete for funding to foster a STEM relationship with NASA for research and development opportunities.

Graduate Student Researchers Program cultivates research ties to the academic community to help meet the continuing needs of the Nation's aeronautics and space effort by increasing the number of highly trained scientists and engineers in aeronautics and space-related disciplines, and broadening the base of students pursuing advanced degrees in science, mathematics, and engineering. The program awards fellowships for graduate study leading to masters or doctoral degrees in the fields of science, mathematics, and engineering related to NASA research and development.

Undergraduate Student Researchers Program attracts undergraduate students from the widest array of backgrounds, who are fully representative of America's racial, ethnic, and cultural diversity; and provides them with hands-on, challenging research experiences that stimulate continued student interest in the fields/disciplines aligned with NASA's research and development mission.

e-Education

Learning Technologies Project (LTP) develops and refines leading-edge or cutting-edge technologies that are in use within NASA missions and/or projects to enhance the teaching and learning of scientific concepts. Technologies funded under LTP are incubated and developed, evaluated, and leveraged with strategic partners to extend reach into educational and commercial applications.

NASA Educational Technologies Services support the publishing and is responsible for maintaining the educational content on the NASA Portal and managing the operation of the Office of Education Web site, and other electronic-based dissemination networks. Additional Web support is provided in the identification and linkage of multimedia resources to support the education video file (education programming) on the NASA TV Public Services channel and NASA TV Education Services channel.

Classroom of the Future conducts empirical educational research then develops and tests off-the-shelf and new or evolving educational technologies that incorporate research findings on cognition and effective application of technology to educational settings. The educational technologies tested and/or developed use NASA research, data sets, or subject matter experts, and are integrated with curriculum support and teacher enhancement activities.

e-Education Small Programs develop infrastructure and deploy research-based technology applications, products, and services to enhance the educational process for formal and informal education. An emphasis is implementation of educational product development, review, and meta-tagging processes and final distribution through approved media, electronic, and/or site-based channels.

Informal Education

NASA Explorer Institutes engage the informal education community, provide instructional materials and resources using NASA content for use at their home institutions, and serve as professional development opportunities for informal education professionals across the Nation.

Minority University Research and Education

University Research Centers provide a broad-based, competitive NASA-related research capability among the Nation's Minority Institutions (MI) that foster new aerospace science and technology concepts; expand the Nation's base for aerospace research and development; develop mechanisms for increased participation by faculty and students of MI in mainstream research; and increase the production of U.S. citizens who have historically been under-represented in NASA-related research and in obtaining advanced degrees in STEM disciplines.

Faculty Awards for Research provides faculty at MI with an opportunity early in their academic careers, to integrate the research and education components with the unique mission requirements of a specific NASA Center. By involving MI faculty and students, the Agency strives to increase the interest and participation of traditionally under-represented students in NASA research programs.

Curriculum Improvement Partnership Award, a three-year undergraduate curriculum improvement program for MI, including Historically Black Colleges and Universities, Hispanic Serving Institutions, Tribal Colleges and Universities, and other MI, emphasizes improvements that are directly related to the NASA mission by infusing innovative learning experiences in STEM into the curriculum.

Research Academy provides leading-edge research opportunities for faculty and students from MI that complements NASA's research programs and make original contributions to NASA in astrobiology, biotechnology, information technology, and nanotechnology. Faculty and students from MI collaborate with the scientists at NASA's Ames Research Center, industry, academia and nonprofit organizations on research that helps prepare the next generation of explorers for NASA missions.

Jenkins Graduate Fellowship Program provides support for under-represented and under-served students in STEM disciplines, including women, minorities, and those with disabilities who seek advanced degrees and opportunities for NASA-related research. The ultimate goal is to facilitate the development of a more inclusive, multicultural and sustainable STEM workforce.

Tribal College and University Program responds to Executive Order 13270, Tribal Colleges and Universities (TCUs), which directs federal agencies to provide support to Tribal College faculty and students. NASA partners with TCUs to increase student and faculty involvement in the excitement of space exploration and cutting-edge technology. The partnership enhances the capacity of TCUs to compete for federal grants and other resources, and provides high-quality educational opportunities to Native American students and faculty.

NASA Administrator's Fellowship Program seeks to increase the ability of Minority Universities to respond to NASA's overall research and development mission. To that goal, NASA Employees spend a year visiting faculty/administrators at minority institutions and members of minority institutions STEM faculty spend a year conducting research at a NASA Center.

MUREP Small Programs support a variety of opportunities for students, teachers, faculty and researchers from under-represented and under-served communities in NASA-related STEM fields.

Additionally, NASA's Offices of Exploration Systems, Science, Aeronautics, Space Operations and other HQ organizations fund education efforts or embed education components into their research and development programs and flight missions, for administering the discipline/content-specific activities for ensuring meaningful collaboration between the NASA science/engineering community and the education community.

Accordingly, NASA is committed to providing opportunities for all children to explore and develop their full learning potential. We will continue to support our nation's elementary and secondary schools, universities, colleges and community colleges by providing exciting research and internship opportunities that will "light the fire" and "fuel the passion" for a new culture of learning and achievement in STEM education.

Career Development

NASA's Agency-level training investment for FY 2005 was $10.2 million, which included training and development activities such as residential training programs, developmental programs, leadership classes, fellowships, and coaching services. The amount budgeted for similar efforts in FY 2006 is approximately $9.2 million. In addition, NASA also funds career development through their Centers' training and development activities.

Questions submitted by Representative Michael M. Honda

Q1. On September 14, the Ames Federal Employee Union sent you a letter describing their concerns about the then pending cancellation of Space Life Sciences and the associated concerns about astronaut health and safety. They have made several unsuccessful attempts to get an answer from NASA HQ. Will you answer their letter? If so, when? not, why?

A1. We apologize for the delay in responding to the e-mail from the Ames Federal Employee Union conveying concerns about cancellation of research at Ames. On March 6, 2006, the Director of the Exploration System's Advanced Capabilities Division, provided the attached response to two Ames Union officials, Paul K. Davis, President and Lee Stone, Vice President for Legislative Affairs.

Date: Wed, 14 Sep 2005 00:06:06 -0700
To: mgriffin@mail.hq.nasa.gov
From: Lee Stone <Leland.S.Stone@nasa.gov>
Subject: Terminating ISS Life Science
Cc: lstone@mail.arc.nasa.gov,pkdavis@mail.arc.nasa.gov

September 14, 2005

Dear Administrator Griffin:

There have been moments in history when NASA management has made colossal errors in judgment that in the fullness of time proved catastrophic. The Columbia Accident Investigation Board rightly identified NASA management's culture of conveniently downplaying risk as a primary cause of the death of seven astronauts and the loss of Colombia.

Today, you are poised to implement a dangerously short-sighted decision.

The Agency is on the verge of eliminating most of its Life Science program just as the President has asked NASA to send human explorers deeper into space and thus farther into harm's way. The International Space Station
(ISS) was built largely to perform Life Science and Biomedical research aimed at properly assessing and mitigating the risks and known adverse consequences to our astronauts of long-duration exposure to microgravity, radiation, high-CO2, and other risk factors of spaceflight. These efforts are aimed at ultimately enabling a safe, successful, manned, round-trip mission to Mars. Specialized facilities, including a centrifuge, were built to establish a rigorous, scientifically valid research and development (R&D) program on the ISS. Now, however, the entire ISS Life Science program is slated for cancellation. When we contacted a senior HQ manager a few weeks ago about this decision, we were told that the decision was a response to recommendations by the Chief Medical Officer
(CMO) and by a Non-Advocate Review (NAR) panel during a zero-base review performed last autumn. We were further told that human health and performance has never been the cause of a spaceflight accident, so this is not deemed a major risk factor.

In response to these 9th floor HQ arguments, we make four simple points: 1. A manned Mars mission or extended lunar stay presents novel challenges for human safety and survival that require long-lead time Life Science R&D and thus must be addressed now if NASA is taking the President's Vision seriously; 2. The CMO is on the record supporting a broad range of Life Science research, including animal research and an

ISS centrifuge, to assess and mitigate risk to astronaut health and safety; 3. The NAR panels did not recommend termination of the ISS Life Science program or centrifuge; and 4. Only two Shuttle flights ago, the same "it hasn't happened so far so it's a low risk" logic was used to argue that foam shedding was not a major risk factor.

The decision to kill NASA's Life Science program was not recommended by Space Life Science experts but rather by Dr. Eugene Trinh (a former astronaut and physicist), despite warnings from numerous Life Science experts inside and outside the Agency calling for the collection of hard data in support of health and performance risk assessment/mitigation as well as spacecraft, operations, and habitat design. NASA's Life Science technical staff, with their collective wisdom and specialized experience in Space Life Science, has been ignored and appears slated to be laid off. Management's decision to silence this uniquely knowledgeable voice may make the problem conveniently fall off the radar -- until a catastrophe occurs leaving a future Administrator to lament at some future memorial service. While it is wonderful that NASA has found astronaut-heroes willing to risk their lives for Space Exploration and for their country, their willingness to sacrifice and their fearlessness should not be abused nor should it dominate decision making at the Agency. Although it appears that a decision to accept an unknown level of risk of human health or performance failure may have been tacitly made, this view must be categorically rejected on ethical grounds alone. The good people of the United States of America will not tolerate the callous view that our astronauts are somehow expendable, even if the astronauts themselves are willing to accept the risk. Another catastrophic accident may kill not only astronauts, but NASA itself.

We know how to get rockets to the Moon and Mars right now; what we don't know is how to keep humans healthy and able to function safely and effectively during a long-duration exploration mission. Even for a short-duration return to the Moon, our limited Apollo experience does not provide a statistically valid basis for assessing the human performance risks (NASA flew many Shuttle missions before it was forced to admit the chilling 1:100 risk of catastrophic Shuttle failure). The President's Vision demands that the ISS be used as originally intended. The ISS should house a Life Science laboratory that acquires real numbers and ascertains real risks, while guiding the development of effective countermeasures including possibly intermittent centrifugation. If not, there is little reason to complete the ISS because, devoid of proper research facilities including a centrifuge, it will provide minimal value to the President's Vision and to the American people.

We are well aware of the serious budgetary constraints you face as you try to chart a course for NASA to implement the President's Vision. However, killing Life Science is simply the wrong decision because it will only recoup a trivial percentage of the total NASA budget. More importantly, a solution to the astronaut health and performance problem is on the critical path of the President's Vision. Failure to address this issue now will ultimately stymie mission success or create significant delays. Furthermore, it is dangerous and unrealistic to think that a Space Life Science R&D program could be easily restored from scratch in the future or that the critical challenges of keeping astronauts safe and healthy during long-duration missions can be solved by severely limited, uncontrolled human experiments performed on a skeleton crew without a centrifuge or other crucial facilities. The main point of the President's call to Exploration was to get NASA out of its rut of short-term, uninspired thinking and to force a grand commitment to real manned Exploration by ordering the journey to start now. For the last 30 years, Mars has been 30 years away. The decision to cancel ISS Life Science is a decision to put the Exploration Vision on hold and to keep Mars 30 years away indefinitely.

The Wall Street Journal (8/11/05) and the New York Times (8/14/05) both called for terminating the Shuttle program and scrapping ISS immediately. It is hard to argue against this position without a solid, scientifically sound research program on ISS. Instead, you argue in response (NYT 8/21/05) that NASA needs to keep its commitment to its foreign partners and to its workforce. Both of these reasons are uncompelling. As far as your commitment to foreign partners, the decision to kill the ISS centrifuge and associated Life Science research program already breaks a long standing promise to one of our key international partners. As far as your commitment to NASA's workforce, you announced last week that more than 10% of NASA's in-house technical employees risk lay-offs within the next year. Clearly, loyalty to our international partners and to NASA employees is not at the core of the decision process.

The bottom line is that killing the ISS Space Life Science program provides aid and comfort to those who argue that NASA should not spend the tens of billions of dollars currently slated for continued operation of an outdated and inherently dangerous Space Transportation System to allow completion of a largely useless yet expensive space station.

We urge that you reconsider your decision.

Respectfully,

Paul K. Davis, President
Lee Stone, Vice President for Legislative Affairs Ames Federal Employee Union IFPTE local 30, AFL-CIO

RESPONSE TO E-MAIL RECEIVED BY DR. GRIFFIN,
SEPTEMBER 14,2005

Paul K. Davis, President
Lee Stone, Vice President for Legislative Affairs
Ames Federal Employee Union
IFPTE Local 30, AFL-CIO
Ames Research Center, California

Dear Mr. Davis and Mr. Stone:

Thank you for expressing your concerns with the reductions to NASA's life sciences program at Ames Research Center (ARC), in your e-mail of September 14, 2005. I am pleased to respond to your concerns, and include the following background to provide a context for NASA's revised direction in human research and technology, which is also discussed below.

In early 2004, the Human System Research and Technology (HSRT) Program of the Exploration Systems Mission Directorate (ESMD) initiated a reorganization of its research and technology development programs. The primary objective of this HSRT program review was to align the legacy Office of Biological and Physical Research programs with the goals of the newly-announced Vision for Space Exploration. A two-stage approach was adopted. In the first stage, the majority of the existing portfolio was examined by HSRT technical and program managers at both NASA Headquarters and the field centers for relevancy to the exploration objectives. Next, a rigorous process was established to quantify the level of each project's effectiveness in contributing to the Vision. A set of scoring criteria was created to allow numerical ranking of each task or activity. The ESMD Level 1 requirements, NASA human health standards and directives, technical relevant research questions found in the Bioastronautics Roadmap (reviewed by the Institute of Medicine of the National Academies), and recommendations found in previous relevant National Academies reports made up the foundation for the set of criteria used. Over one-third of the existing research tasks were classified as not being directly linked to the exploration objectives and those topical areas were recommended for phase out.

A set of program priorities and preliminary recommendations for associated program enhancements was established. The identified priorities were:
1. Space Radiation Health and Shielding
2. Advanced Environment Control and Monitoring
3. Advanced Extra Vehicular Activities suits
4. Human Health and Countermeasures
5. Advanced Life Support
6. Space Human Factors and Behavioral Health

This information was compiled, analyzed and presented to NASA's senior management and advisory committees for review and approval. The information was then briefed in detail to the House Science Committee and Space and Aeronautics Subcommittee, and to the Senate Commerce Committee and Science and Space Subcommittee. Following these briefings, the information was provided to the Exploration Systems Architecture Study (ESAS), a panel commissioned by Administrator Griffin to provide the initial architecture for implementing the Vision for Space Exploration.

On September 19, 2005, NASA announced the results of the ESAS, which provides a blueprint for the future of human and robotic space exploration. The resulting exploration architecture builds on the best of the Apollo program and Space Shuttle technology to create a 21st century exploration system that will be affordable, reliable, versatile, and safe. An important ESAS priority was to accelerate the development of the new Crew Exploration Vehicle to replace the Space Shuttle, scheduled for retirement in 2010.

With the ESAS architecture plan in place, NASA's Exploration Systems Mission Directorate (ESMD) has completed a realignment of its existing research portfolio to focus on work that represents the highest priority research in support of these newly defined goals. Research efforts that are not as closely aligned with the critical, near-term technology goals of the new exploration architecture are subject to reduction or cancellation. Investments in some life sciences research has been reduced or deferred, as the research was not identified as critical to meeting our near-term development needs. However, in an effort to keep a balanced research program while NASA concurrently implements the Vision for Space Exploration, ESMD will include a fundamental life sciences research component. This component of the program is in development. Areas of research that are important, but not considered in the critical path, such as molecular biology, will be reassessed.

There will be new, but reduced, NASA research opportunities in biomedical science. The life sciences research portfolio content has

shifted from lower Technology Readiness Levels (TRLs) to higher TRLs with more specific, directed outcomes than was required in the past. The Bioastronautics Roadmap and associated risk reduction approach will continue to be a guide in research solicitations and directions. NASA intends to adopt a "standards to deliverables" paradigm supported by an up-to-date knowledge base as a major determinant of future human system research efforts. The Office of the Chief Health and Medical Officer has established eight space flight health standards that will be our guide in determining the appropriate research to conduct. The ISS Medical Project (ISSMP) will focus on critical research aboard ISS to enable development of countermeasures to meet these standards. This approach will provide the ability to identify essential gaps addressable by appropriate solicited research.

NASA acknowledges the current impact of difficult, resource-driven decisions that must be made in order to implement and meet the objectives of a decisively bold space exploration initiative. While it may not be possible to ameliorate the near term effect of the Agency's redirection of research activity, we are committed to retaining a core of life and physical sciences research that will help to maintain a level of continuity in these discipline areas for the future.

I hope this information is useful to you and provides reassurance that NASA is continuing to implement a balanced research program with all essential elements included.

Sincerely,

Carl Walz
Division Director
Advanced Capabilities
Exploration Systems Mission Directorate

Q2. What Life Science expert advice, either in-house or external, did you seek before making your decision to terminate NASA's Space Life Sciences program? What was the recommendation of the Chief Medical Officer? What was the recommendation of academic Life Science experts? What was the recommendation of your in-house Life Science experts?

A2. The Human Research program content, including biomedical and fundamental biology research tasks, has undergone a series of internal and external reviews in recent years. The non-NASA community of researchers performed a major content review of the Exploration System Mission Directorate's (ESMD) research priorities during the Research Maximization and Prioritization Task Force (ReMap) in 2002, and provided comprehensive rankings and recommendations at that time. Beginning in the fall of 2004 and concluding in early 2005, ESMD conducted a Zero Based Review (ZBR) of the Human Systems Research & Technology (HSRT) research portfolio. The ZBR was conducted in order to reprioritize HSRT research to support the VSE, following the merger of Exploration with Biological and Physical Research. All 900 research tasks were collected and subdivided, rated with weighting factors and criteria for exploration-relevant research, and a series of non-advocate panels then examined ESMD's ZBR process. As a result of the ZBR, research not directly supporting exploration priorities was shifted to a longer-term ranking within ESMD, much of which was targeted to be gradually phased out of the program. The ZBR created a research baseline that was the focus of the Exploration Systems Architecture Study (ESAS). The ESAS Technology Assessment Report is a further narrowing of the ZBR priorities to very specific requirements emphasizing near-term needs for a return to the Moon. After ESAS, ESMD also emphasized the need to maximize use of the International Space Station to perform research needed for Mars mission risk reduction. The priorities resulting from the ESAS studies were then reviewed by the Office of the Chief Health and Medical Officer, specifically to ensure these ESAS recommendations did not result in compromise to crew health and safety in near-term missions or in proposed mission architectures, through six-month lunar stay.

Q3. In your testimony, you said: "The human life science research of which you spoke is there to support human exploration. It seemed to me that it was getting the cart before the horse to be worrying about money for human or other life sciences when we could not assure ourselves the continued capability to be able to place people in orbit in the first place. So my priority became assuring that the United States would have as close to continuous capability to put people in space first and then conducting the research on them after that."

- *After the* Columbia *Accident Investigation Board, as part of NASA HQ's painful rehabilitation from the Board finding that NASA's management culture was a primary contributor to the disaster, the Administrator made a commitment to put astronaut safety first. How is your answer consistent with that pledge made by your predecessor only a few short years ago? You appear to be saying that the safety cart must go after the mission horse and that NASA needs to get astronauts back to Space and the Moon first and then determine the risks to their health and safety second. Would you care to respond?*

A3. As a result of the Exploration Systems Architecture Study (ESAS), the Human Research Program will have a reduced and clearly focused scope. The Human Research Program will focus on near-term Agency goals of supporting Crew Exploration Vehicle (CEV) and lunar mission requirements by developing countermeasures to meet, and knowledge to inform, the Office of the Chief Health and Medical Officer (OCHMO) Space Flight Health and Human Performance Standards. The budget and content for Human Research that were recommended by ESAS was further reviewed by the Office of the Chief Health and Medical Officer, specifically to ensure these ESAS recommendations did not result in compromise to crew health and safety in near-term missions or in proposed mission architectures, through six-month lunar stays.

Human health and performance issues are only a small portion of the risk to astronauts. The active portions of space missions, launch, rendezvous, entry and landing, present tremendous risks to the lives of astronauts that are extremely significant. We have had a long history of successful space missions both in low-Earth orbit and on the lunar surface. U.S. astronauts routinely stay in space for up to six months without demonstrable, permanent short-term untoward health effects upon return. Possible long-term health effects are still being evaluated through the Longitudinal Study of Astronaut Health. We have lost our crew members during launch and during entry. We must ensure that they have a safer method of transportation

from Earth to space. That is one reason why we are investing in the CEV, a safer replacement for the Space Shuttle.

Q4. NASA HQ appears to have decided that an Apollo-like return to the Moon poses no risks related to human health and performance. What risk assessment was performed to support this view? How can the handful of successful Apollo Moon missions (with one mechanical failure) allow HQ to determine that there is little risk of a catastrophic human error or health crisis in short-duration lunar missions?

A4. No mission in space is without risk, whether that mission is a short duration Shuttle mission, a long duration International Space Station (ISS) mission, or a mission to the lunar surface. The risk and reliability assessment of the ESAS was an integral element of the architectural design process. It should be noted that the chosen ESAS architecture has a higher ascent crew safety (approximately one in 2,000 risk for loss of crew) than that of the Space Shuttle (one in 220 loss of crew). In general, the risk of loss of mission decreases with the maturation of key technologies.

The biomedical operations and research community has been and is involved in supporting the U.S. and international human element of every major NASA human space flight program, including Mercury, Gemini, Apollo, Skylab, Apollo-Soyuz Test Project, Shuttle, Spacelab, NASA/Mir, and ISS. As of October 2005:

- Persons who have flown in orbit: 437
- 28,421 crew-days (77.5 years)
- Shuttle (1981–2005)—6,352 crew-days (17 years)
- Skylab (1973–1974)—504 crew-days (1.4 years)
- NASA/Mir (1994–1998)—849 crew-days (2.3 years)

As a result of this extensive experience, it is known that medical, environmental and human error events do happen. Failures in countermeasures and monitoring equipment lead to an increased likelihood of adverse events, but there are also tradeoffs between the medical level of care and other mission constraints. Exploration requires a focused human health and safety research and operations program. Therefore, the Human Research Program has been tasked with building on this long history of involvement in human space flight and the resulting body of knowledge to develop the countermeasures, tools, knowledge and capabilities necessary to ensure the safety and health of our crews returning to the Moon. The Human Research Program will work actively with office of the Chief Health and Medical Officer, the Office of Safety and Mission Assurance, the National Academies, academia, and the Astronaut Office to assure that all aspect of human health and performance are considered as we prepare for a return to the Moon.

Q5. In Dr. Porter's initial plan to totally revamp NASA's aeronautics R&D programs, she decided to make large cuts in key Aviation Human Factors programs (in both the Airspace Systems and Aviation Safety programs). Human performance capabilities and limitations play a key role in the design of modern human-automation systems either on the flight deck or for air traffic management. Experts in the field of automation and human performance emphasize that relying on technology and automation per se to prevent accidents will not work and may even introduce new serious risks.

- *Given that advancing human-centered design and related technologies will be a key element in any effective reduction in commercial aviation accidents or increase in efficiency, in what way will NASA's new R&D portfolio support activities in Human-System Interactions?*
- *Given that human performance has been identified as a major factor in the great majority of aviation accidents by every major study published, why are human performance issues subordinated to hardware/software technology development in the new Aviation Safety and Airspace systems programs?*

A5. Within the Aviation Safety Program, research focused on Human-System Interactions will be part of the Integrated Intelligent Flight Deck (IIFD) Technologies thrust area currently being planned. A ten-year roadmap for integrated multi-disciplinary research has been developed that captures the breadth of research needs for improved flight deck system safety. It is important to note that the research agenda considers the notion of a flight deck system wherein one or more human operators are elements of this system. This acknowledges the fact that the act of safely directing a flight in current and future operational environments requires a complex system whose behavior will result from a strong coupling of physical processes,

human behavior, and computer-controlled systems. As a result, an overarching guideline is promoted to apply an integrated holistic approach in order to bring about new system-level capabilities, such as those envisioned by the NGATS, while simultaneously improving safety.

Because human behavior is a critical element that has been shown to have a significant impact on the performance/safety of flight deck systems, the study of human factors issues is also essential. However, the study of human factors must be focused or applied to the functional capabilities required by future flight deck and operational environments. The research portfolio that has been defined considers human factors in a manner similar to other important disciplines such as computer science, physics, and systems engineering. Each of these fundamental disciplines and others will be drawn upon as appropriate in the research to address safety issues associated with required functional capabilities.

The ten-year roadmap of research milestones was developed by a group of senior NASA researchers that included several human factors specialists who have been applying human factors tenets to aviation problems for many years. As a result, evidence of human factors-related research activities can be found throughout the envisioned effort. Perhaps the most important example is cited in the recurring milestone to develop/refine model-based flight deck design tools that can be reconfigured to accommodate changes in system hardware/software, user characteristics, and environmental conditions while also accommodating human-centered designs.

Human error has been consistently sited as a major factor to the cause of many aircraft accidents (about 60–80 percent). Although the planning is still ongoing, and we will be doing less research in some areas, human performance issues have not been subordinated to other technologies. As described above, we see the need for a multi-disciplinary holistic approach due to the strong coupling of human operator(s) behavior and performance with computer-based systems and physical processes that affect the flight and/or measurements made by on-board sensors. None of these three disciplines are viewed more or less significant than the others.

In addition, human-systems integration and adaptation and the related human performance factors have been included in the planning for foundational research investment in the Airspace Systems Program. Foundational research is not subordinate but rather critical to the long-term success of integrated system solutions. Selected principal investigators will work within the Airspace System Program and across all Aeronautics programs over the next several months to define further the specific human factors research elements to be included in the programs.

The draft milestone charts and schedules for all the Aeronautics planning activities are available at *www.aeronautics.nasa.gov* and were presented to the public at the AIAA Conference on January 12, 2006. The portfolio of proposed activities are still under development at the NASA Research Centers and will be implemented after first being peer reviewed by non-NASA, and non-ARMD representatives for technical accuracy and relevance.

Q6. NASA asserted in its responses to OMB questions that "For commercial transports, system and component failures were a causal factor in approximately 70 percent of aircraft incidents."

Q6a. Please provide the NTSB data and analysis used to support this assertion.

A6a. The NTSB maintains the Accident/Incident Database, the government's official repository of aviation accident data and causal factors for civil aviation accidents. The database was established in 1962 by the NTSB's predecessor agency, the Civil Aeronautics Board, and about 2,000 new events records are added each year. The record for each aviation accident contains data about the aircraft, environment, injuries, sequence of accident events, and other topics. The database is available to the public at *×ftp://www.ntsb.gov/avdata/*>. The time frames used for the NASA analysis were incidents recorded from 1990 to 1996, involving Part 121 & 135 Scheduled Flights. For these categories, there were about 5,500 incidents noted and of those 3800 (~70 percent) involved a system malfunction, propulsion malfunction, landing gear failure, or loss of directional control.

Q6b. What is meant by "incident" in this assertion? Why did NASA look at incidents rather than accidents when developing its safety policy? Is not NASA's mission in Aviation Safety to reduce accidents and dangerous close-calls that threaten the flying public not minor incidents?

A6b. An "accident" is defined in 49 CFR Part 830.2 as—

"An occurrence associated with the operation of an aircraft which takes place between the time any person boards the aircraft with the intention of flight and

all such persons have disembarked, and in which any person suffers death or serious injury, or in which the aircraft received substantial damage."

An "incident" is defined in 49 CFR Part 830.2 as—

"An occurrence other than an accident, associated with the operation of an aircraft, which affects or could affect the safety of operations."

In the case of most accident findings, the accident was a result of two or more faults and/or errors that aligned together in a deadly sequence that led up to a catastrophic event. Given, an accident is a rare event, a pro-active approach to accident prevention is to identify and eliminate any systemic faults before they ever come together as an accident. An assessment of incident data is a primary means of identifying faults currently in the air transportation system that could some day be a contributing factor to the cause of a fatal accident.

Q7. In what way did NASA consult with the aviation industry (including operators and manufacturers) in choosing the major program elements for each of its three aeronautics programs? Did NASA consult with its own experts on the causes of aviation accidents? Has NASA consulted industry organizations such as the Airline Transport Association, the Airline Pilots Association, and the Flight Safety Foundation? What do these industry organizations say about what they need from NASA to improve safety and to improve U.S. competitiveness?

A7. At the beginning of the first focused Safety Program in 1997, NASA sponsored a series of workshops with industry and government participants to identify and prioritize NASA's portfolio of safety research activities that would support the National Goal to reduce the fatal accident rate. As the second phase of the Safety program was being planned in 2004, NASA conducted another workshop with industry and government participation to refine and prioritize NASA's portfolio of proposed Safety research activities. In addition to NASA's own expertise, participation at both workshops included representatives from ATA, Boeing, the airlines, avionics suppliers, the FAA, and other government agencies. Even though the current planning reflects a shift to more fundamental research, previous findings of the safety workshops influenced establishment of the Integrated Intelligent Flight Deck and the Integrated Resilient Aircraft Control thrust areas. Furthermore, NASA issued a Request for Information (RFI) on January 3rd to solicit input from industry to include interest in collaborative non-reimbursable partnerships in the proposed research areas. Responses to the RFI were due January 31, and for the Safety Program we received input from a least 35 industry organizations expressing an interest to collaborate.

The Airspace Systems Program (and its partner programs in NASA's Aeronautics Research Mission Directorate) is seeking partnership with industry to further define and collaborate on systems level technologies. These pre-competitive consortia will support the long-term goals of the program. In addition, the relevant vision for ASP (that of the JPDO NGATS 2025) was developed at its earliest stages with substantial aviation industry input.

The initial formulation of the Fundamental Aeronautics Program used in-house expertise to identify aeronautics challenges within the areas of hypersonics, supersonics, and subsonics. This expertise draws its knowledge base from the foundation developed via long standing partnerships within the aviation industry. Now in the second phase of formulation, Fundamental Aeronautics released an RFI soliciting interest primarily from industry to collaborate at the systems level. The RFI generated over 140 responses. The collaborations are expected to benefit both industry and NASA.

Q8. What link is there between NASA's new aeronautics plan and the analyses of aviation safety made over the years, e.g., Boeing's annual reports on commercial aviation accidents, JSAT, CAST, the Gore Commission, NTSB Safety Studies? How do the new thrusts proposed for NASA's aviation safety program address industry's safety concerns?

A8. As implied in the response to Question 7, NASA has collaborated with Boeing and other external organizations as it planned for and implemented previous Safety Programs. The first Safety Program, initiated in 1997, was directly tied to the findings of the Gore Commission which set a National Goal to reduce the fatal accident rate by 80 percent. In addition, the NASA Aviation Safety Program Director is a member of the Executive Committee of the Commercial Aviation Safety Team (CAST), and NASA representatives have participated on the Joint Safety Analysis Teams that directly report to the CAST. FAA representatives from the CAST have been asked and have agreed to review and comment on the research activities currently being planned in the Aviation Safety thrust areas.

Q9. Why has NASA excluded Human Factors issues from many of the new Aeronautics program elements? For example, it is not possible to design aircraft computers to automatically recover from upset attitudes without including crew performance as a central issue, yet the crew performance issues are excluded from the new Integrated Resilient Aircraft Control program element. Another example is that has NASA has excluded Human Factors issues related to operating procedures, maintenance, and training from its Aging Aircraft program element even though these issues have been identified by Boeing as a major concern when second and third tier airline operators with limited resources acquire older aircraft? Why is Human Factors not considered a fundamental element of aeronautics R&D that cuts across vehicle classes (subsonic, rotorcraft, supersonic, hypersonic) and Air Traffic management?

A9. As stated in response to Question 5, human performance issues have not been subordinated to other technologies nor have they been fully excluded, although we will be doing less in some areas. The planning is still underway, and we are taking a more holistic approach across all technology disciplines to include a more integrated approach across the program thrust areas. Human performance research requirements will not be isolated to within each thrust area. For example, requirements identified for the automation, autonomy, and crew interface issues of the Integrated Resilient Aircraft Control (IRAC) are intended to be addressed in the human performance activities of the Integrated Intelligent Flight Deck (IIFD) thrust area. Accordingly, the IRAC planning team has a Crew Systems Specialist assigned to their team to ensure that human factors issues are addressed and coordinated with the IIFD. The status of planning activities is located at *www.aeronautics.nasa.gov*.

Human Factors issues have been explicitly included in the Airspace Systems Program at its most fundamental levels as a result of the technical workshop planning conducted by NASA's research community. Selected principal investigators will work within the Airspace System Program and across all Aeronautics programs over the next several months to further define the specific human factors research elements to be included in the programs.

In Fundamental Aeronautics, we have made a commitment to the technologies that constitute advanced guidance, navigation, and control. Therefore we are integrating human factors research in situations where it makes sense. Given that the likelihood of a human-piloted hypersonic vehicle is low, we see little need for human factors work in hypersonics. On the other hand, human factors research plays a first-order role in the control of rotorcraft, and we are integrating human factors research into that area of the program. In short, we continue to work human factors research in areas where it is important.

Questions submitted Representative Sheila Jackson Lee

Q1. Funding-wise, the Administration will face a crisis in terms of its workforce. The way that the request is structured, the number of full-time equivalents (FTEs) will be reduced from 19,227 in FY 2005 to 16,738 by the end of FY 2006.

- *How do you propose the Administration will maximize efficiencies in technology with such a drastic reduction in workforce?*
- *Is one official charged with the duty of deciding whom to release pursuant to the plan to reduce the workforce?*

A1. The recently released President's FY 2007 Budget reflects the current situation and shows the actual FTE used in FY 2005 of 18,624, and estimates FY 2006 FTE at 18,410 and FY 2007 FTE at 17,979. The reasons for the change from the President's FY 2006 Budget is that Administrator Griffin has made a decision to restore and ensure NASA's core intellectual capabilities now and into the future. The Agency is determined to find ways to preserve and maintain the knowledge base of the current workforce, broaden and reinvigorate current skills and acquire new ones as they are needed. Successful accomplishment of the NASA mission requires ten fully engaged and productive field Centers. NASA is committed to ensuring the vitality of these Centers, each with a clear mission, a role in making the Vision a reality, and sufficient funding and workload to sustain its workforce.

As a result of the NASA Administrator's decisions stated above, the President's FY 2007 Budget for FY 2007 of 17,979 FTE is now 1,241 FTE higher than the FY 2006 President's Budget submission for FY 2007 of 16,738 FTE.

Q2. Relative to space exploration, the Hubble Space Telescope servicing mission commitment seems tenuous. What is the Administration's plan with regard to Hubble?

A2. The Hubble Space Telescope Program is continuing to prepare plans for a possible Hubble servicing mission in early FY 2008. The decision to proceed with a servicing mission will not be made until after the Space Shuttle's 2nd Return-to-Flight mission. The FY 2007 budget supports this servicing mission.

Q3. At your April 2005 confirmation hearing, you indicated that "the total amount of NASA funding is not the problem, NASA received approximately the same amount of money in its fast 16 years as it has in the past 16 years. Instead. . .it is a matter of setting priorities." *Your chief priorities as enumerated were returning the Shuttle to flight and making each flight as safe as possible, completing construction of the space station by 2010, terminating the Shuttle in 2010, and accelerating the development of the CEV to minimize the gap between when the Shuttle ends and the CEV is available. Where will you make cuts to meet these goals given the funding levels contained in the* SSJC Appropriations Act for FY 2006*?*

A3. NASA's FY 2007 budget request includes the resources necessary to address the priorities of the President and the Congress, including completing assembly of the Space Station and fulfilling our commitment to our international partners, retiring the Space Shuttle by 2010, and bringing the Crew Exploration Vehicle online in a timely manner, not later than 2014 and potentially much sooner. This budget request for Space Operations (including Space Shuttle and Space Station) is based on credible estimates of Space Shuttle retirement and transition costs and is no longer a placeholder budget as it was in previous budget requests.

In previous budget requests, NASA reported only placeholder budget estimates for the Space Shuttle for FY 2008–10. The Agency's management focus on return-to-flight efforts of the Space Shuttle resulted in NASA deferring this analysis until the FY 2007 budget. Early in the budget process, NASA's estimates of the budget shortfall required to safely fly the Space Shuttle with the minimum number of flights necessary to complete ISS assembly and meet our international partner commitments were $3–5 billion. With the FY 2007 budget runout, NASA has added $2.4 billion to the Space Shuttle program and almost $1.5 billion to the International Space Station in FY 2008–10 compared to the FY 2006 budget runout. There is no "new money" for the NASA topline budget within the budget projections available given our nation's other pressing issues, so working with the White House, NASA provided sufficient funds for the Space Shuttle and ISS programs to carry out their missions by redirecting funds from the Science (about $2.4 billion) and Exploration (about $1.4 billion) budgets.

With regard to ensuring timely development of the CEV, the Exploration Systems Mission Directorate (ESMD) has redirected funds within its overall budget, from longer-term and lower-priority technology activities into the Constellation budget for development of the CEV and its launch system. This shift of funding internal to ESMD reflects the results of the Exploration Systems Architecture Study (ESAS), and is consistent with notifications provided to the Congress in the September 30, 2005, update to the FY 2005 Operating Plan.

Question submitted by Representative Brian Baird

Q1. With NASA placing its top priority on programs like the Space Shuttle, the International Space Station, development of the new Crew Exploration Vehicle, and development of a new heavy-lift launch vehicle, what are your plans for the Earth Science program, and what priority will they have relative to the Agency's other missions?

A1. As outlined in the 2006 NASA Strategic Plan, it is a strategic goal of NASA to study the Earth from space so as to advance scientific understanding of our planet and its dynamic processes and also to meet vital societal needs. NASA will conduct a robust program of utilization of the current Earth science space assets and databases. This includes such things as the operation of the Earth Observation Satellite system, which is the world's most sophisticated tool for measuring, documenting, and conducting research on weather processes and climate change. Through interagency activities with the Department of Defense, National Science Foundation and National Oceanic and Atmospheric Administration this research will be used to improve predictive capabilities for weather and climate models for national economic benefit. This budget provides for extended operations for many

of these missions in order to benefit from the additional scientific insights that these missions continue to offer.

NASA will also operate a fleet of scientific satellites in extended mission status to develop and communicate new scientific knowledge concerning the Earth and its processes. Looking forward, the Earth Sciences Division is currently developing nine new missions for future scientific investigations. These include Cloudsat and CALIPSO, OCO and Aquarius, Glory, the Global Precipitation Measurement Mission, the Ocean Surface Topography Mission, the National Polar-Orbiting Operational Satellite System Preparatory Project satellite, and in collaboration with the US Geological Survey, a Landsat mission to secure land data from space.

Thus, the Earth Science program within the SMD is a vital part of the Agency's science portfolio, currently configured and funded to make significant cultural, intellectual, economic and political contributions to the Nation.